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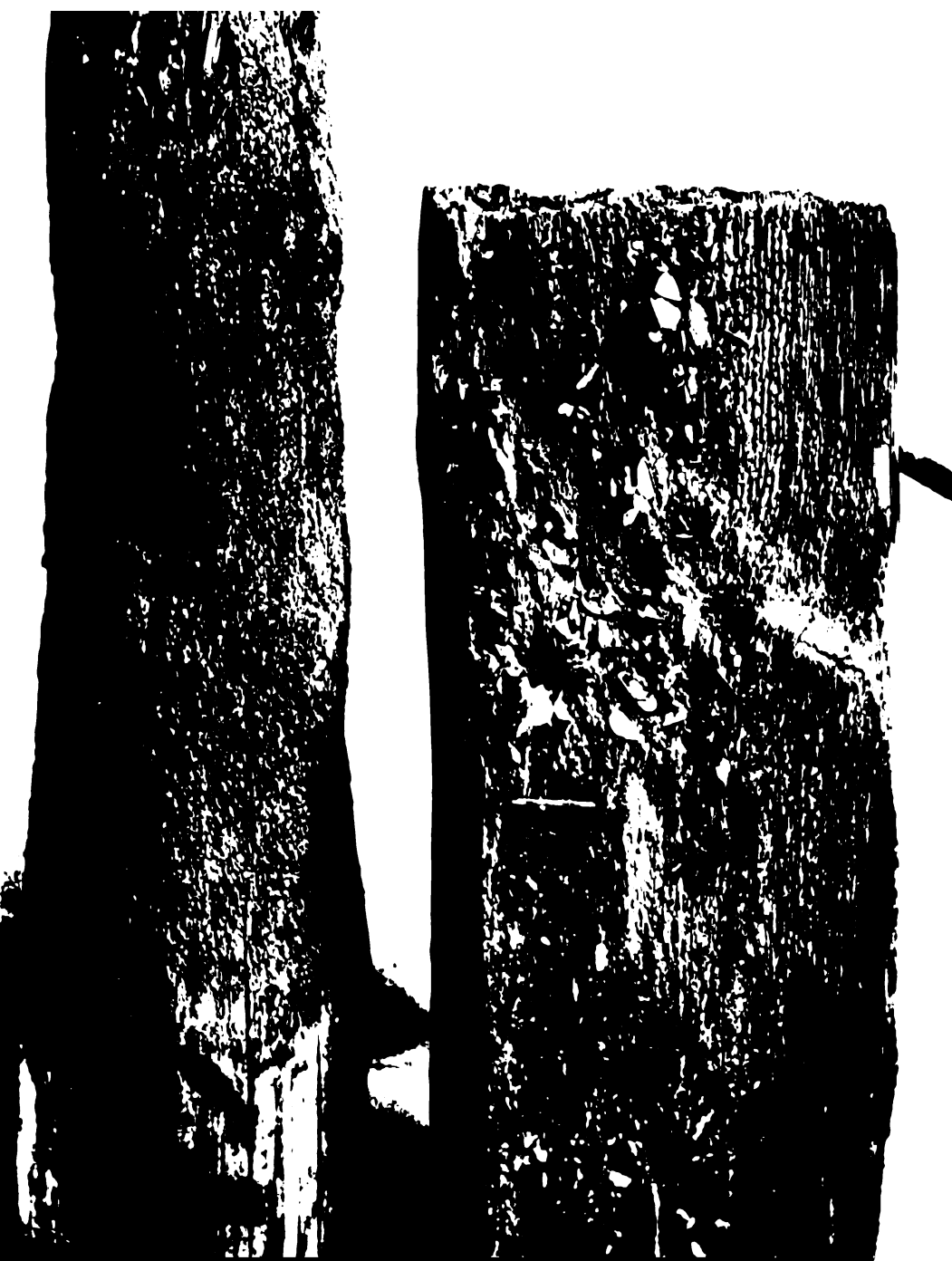
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# *Annual Report*

Boston (Mass.). Engineering Dept











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TWENTY-FIRST ANNUAL REPORT

OF THE

CITY ENGINEER

FOR THE YEAR 1887.



BOSTON:  
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1888.



# CITY OF BOSTON.



## TWENTY-FIRST ANNUAL REPORT

OF THE

# CITY ENGINEER,

FOR THE YEAR 1887.

OFFICE OF THE CITY ENGINEER, CITY HALL,  
BOSTON, January 2, 1888.

*To the Honorable City Council : —*

In compliance with the seventh section of the ordinance relating to the Engineer's Department, the following report of the expenses and operations of the department for the year 1887 is respectfully submitted.

The duties of the City Engineer may be classified under the following heads : —

A. — Those pertaining to the City Engineer's Department proper, which consist in examination and supervision of structural repairs of bridges ; in designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council. (City Engineer's Department.)

B. — Superintendence of the Sudbury River, Cochituate, and Mystic Water-Works, including charge of new constructions for these works. (Water-Works.)

C. — Charge of the construction of a system of intercepting and outlet sewers. (Improved Sewerage, or Main Drainage.)

D. — Charge of the engineering work in connection with the Back Bay and other proposed parks. (Parks.)

The expenses incurred under the head C are paid wholly from a special appropriation.

A. — CITY ENGINEER'S DEPARTMENT.

The following is a statement of engineering expenses from January 1, 1887, to January 1, 1888:—

Amount expended from department appropriation for 1886-87 . . . . .	\$8,695 16
Amount expended from department appropriation for 1887-88 . . . . .	23,527 47
Total . . . . .	<u>\$32,222 63</u>

Condition of department appropriation:—

Amount of appropriation for financial year 1887-88 . . . . .	\$33,000 00
Amount expended to January 1, 1888 . . . . .	23,527 47
Unexpended balance, January 1, 1888 . . . . .	<u>\$9,472 53</u>

CLASSIFICATION OF EXPENSES.

Salaries of City Engineer, assistants, draughtsmen, transit-men, levellers, rod-men, etc. . . . .	\$29,443 75
Engineering instruments and repairs of same . . . . .	235 12
Drawing-paper, and all materials for making plans . . . . .	314 08
Stationery, printing-stock, note-books, postage, etc. . . . .	307 11
Reference library, binding books, and photographs of work . . . . .	257 43
Printing . . . . .	65 30
Travelling expenses (including horse-keeping, repairs on vehicle, etc.) . . . . .	756 37
Telephone service . . . . .	120 00
Furniture cases for plans and books, etc. . . . .	346 04
Blue-process printing . . . . .	122 39
Incidental expenses, and all other small supplies . . . . .	255 04
Total . . . . .	<u>\$32,222 63</u>

The number of persons employed and paid from the department appropriation was, on the 1st of January, 1887 (including the City Engineer), 20. The present number is

20. The operations of the department for the year, together with such general information relating to the various works and structures, finished and in progress, as is thought to be of interest, are given in the following statements : —

## BRIDGES.

In accordance with Section 5, Chapter 18, of the Revised Ordinances, the estimates of cost of repairs submitted by the Superintendent of Bridges has been revised and reported upon, and structural repairs required have been ordered and supervised.

As required by Section 4 of the above, examinations have been made of all bridges within the city limits.

The name of the bridge at Cottage Farm, over the Boston & Albany Railroad, has been changed from Brighton avenue to Commonwealth avenue, on account of the change in the name of the avenue.

In the list those marked with an asterisk are over navigable waters, and are each provided with a draw.

### I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Ashland street, Ward 23, over Boston & Providence Railroad.

Athens street, over N.Y. & N.E. Railroad.

Beacon Entrance, Back Bay, over Boston & Albany Railroad.

Beacon street, over outlet to Back Bay.

Beacon street, over Boston & Albany Railroad.

Berkeley street, over Boston & Albany Railroad.

Berkeley street, over Boston & Providence Railroad.

Blakemore street, over Boston & Providence Railroad, Ward 23.

Boylston street, in Back Bay.

\*Broadway, over Fort Point Channel.

Broadway, over Boston & Albany Railroad.

Brookline avenue, over Boston & Albany Railroad.

\*Charles river, from Boston to Charlestown.

\*Chelsea (South), over South Channel, Mystic river.

\*Chelsea street, from East Boston to Chelsea.

Columbus avenue, over Boston & Albany Railroad.

\*Commercial Point, or Tenean, Ward 24.

\*Commonwealth avenue, in Back Bay.

Congress street, over Fort Point Channel.

Dartmouth street, over Boston & Albany and Boston & Providence Railroads.



- \*Dover street, over Fort Point Channel.
- \*Federal street, over Fort Point Channel.
- Ferdinand street, over Boston & Albany Railroad.
- Franklin-street foot-bridge, over Boston & Albany Railroad.
- Huntington avenue, over Boston & Albany Railroad.
- Linden Park street, over Stony Brook.
- \*Malden, from Charlestown to Everett.
- \*Meridian street, from East Boston to Chelsea.
- \*Mt. Washington avenue, over Fort Point Channel.
- Newton street, over Boston & Providence Railroad.
- Public Garden foot-bridge.
- Shawmut avenue, over Boston & Albany Railroad.
- Swett street, east of N.Y. & N.E. Railroad.
- Swett street, west of N.Y. & N.E. Railroad.
- \*Warren, from Boston to Charlestown.
- West Chester park, over Boston & Albany Railroad.
- West Chester park, over Boston & Providence Railroad.
- West Rutland-square foot-bridge, over Boston & Providence Railroad.
- Winthrop, from Breed's Island to Winthrop.

## II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

- \*Cambridge street, from Brighton to Cambridge.
- Central avenue, from Ward 24 to Milton.
- \*Chelsea (North), from Charlestown to Chelsea.
- \*Essex street, from Ward 25 (Brookline) to Cambridge.
- \*Granite, from Dorchester, Ward 24, to Milton.
- Longwood avenue, from Ward 22 to Brookline.
- Mattapan, from Ward 24 to Milton.
- Milton, from Ward 24 to Milton.
- \*Neponset, from Ward 24 to Quincy.
- \*North Beacon street, from Brighton to Watertown.
- \*North Harvard street, from Brighton to Cambridge.
- Spring street, from West Roxbury to Dedham.
- \*Western avenue, from Brighton to Cambridge.
- \*Western avenue, from Brighton to Watertown.

## III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

- Albany street, over Boston & Albany Railroad.
- \*Canal, from Boston to Cambridge.
- Dorchester street, over Old Colony Railroad.
- \*Prison Point, from Charlestown to Cambridge.
- \*West Boston, from Boston to Cambridge.

## IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

*1st. — Boston & Albany Railroad.*

Commonwealth avenue, Brighton.  
Harrison avenue.  
Market street, Brighton.  
Tremont street.  
Washington street.

*2d. — Boston & Maine Railroad.*

Mystic avenue.  
Main street.

*3d. — Boston & Maine Railroad, Eastern Division.*

Mystic avenue.  
Main street.

*4th. — Boston & Providence Railroad.*

Beech street, Ward 23.  
Bellevue street, Ward 23.  
Canterbury street, Ward 23.  
Centre street, or Hog Bridge, Ward 23.  
Centre and Mt. Vernon streets, Ward 23.  
Dudley avenue, Ward 23.  
Park street, Ward 23.

*5th. — Boston, Revere Beach, & Lynn Railroad.*

Everett street.

*6th. — New York & New England Railroad.*

Broadway.  
Dorchester avenue.  
Fifth street.  
Forest Hills avenue, Ward 24.  
Fourth street.  
Harvard street, Ward 24.  
Norfolk “ “ “  
Norfolk “ “ “  
Second street.  
Silver street.  
Sixth street.  
Third street.  
Washington street, Ward 24.

*7th. — Old Colony Railroad.*

Adams street.

Ashmont street and Dorchester avenue.

Cedar Grove Cemetery.

Commercial street.

Savin Hill avenue.

#### RECAPITULATION.

I.	Number wholly supported by Boston . . . . .	39
II.	Number of which Boston supports the part with- in its limits . . . . .	14
III.	Number of which Boston pays a part of the cost of maintenance . . . . .	5
IV.	Number supported by Railroad Corporations : —	
1.	Boston & Albany . . . . .	5
2.	Boston & Maine . . . . .	2
3.	“ “ Eastern Div. . . . .	2
4.	Boston & Providence . . . . .	7
5.	Boston, Revere Beach, & Lynn . . . . .	1
6.	New York & New England . . . . .	13
7.	Old Colony . . . . .	5
	Total number . . . . .	93

#### I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

##### ASHLAND-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD, WARD 23).

This bridge is in good condition.

##### ATHENS-STREET BRIDGE (OVER NEW YORK & NEW ENG- LAND RAILROAD).

This bridge needs painting ; otherwise it is in good condition.

##### BEACON-ENTRANCE BRIDGE (IN BACK BAY, OVER BOSTON & ALBANY RAILROAD).

This bridge has been painted, and the roadway sheathed.  
It is in good condition.

##### BEACON-STREET BRIDGE (OVER OUTLET OF BACK BAY).

This bridge is in good condition.

**BEACON-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is not yet in use. The street has been widened, and the bridge is now being changed from 70 ft. to 94 ft. in width, by and at the expense of the West End Land Company. The abutments have been finished, but the addition to the iron bridge is not yet done.

**BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge has been repaired by replacing the roadway floor-beams which were defective, and laying new under and upper floors. The sidewalks should be renewed this year. The bridge is in good condition, but it is a weak structure.

**BERKELEY-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

The concrete surface and the plank under floor of the sidewalk is in poor condition; a part of the bridge is in need of painting.

**BLAKEMORE-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This bridge is in good condition.

**BOYLSTON-STREET BRIDGE (IN BACK BAY).**

The parapet and portions of the masonry are in need of pointing, otherwise it is in good condition. This bridge is maintained by the Park Department.

**\*BROADWAY BRIDGE (OVER FORT POINT CHANNEL).**

The under floor has been relaid on one 100-foot span, and the bridge was painted partly in 1886 and partly in 1887. The floor of the remaining 100-foot span should be renewed; otherwise the bridge is in good condition.

**BROADWAY BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

The bridge has been painted throughout, the floor having been removed for the purpose. It is in good condition.

**BROOKLINE-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge has been painted, and it is in good condition.

**\*CHARLES-RIVER BRIDGE (FROM BOSTON TO CHARLES-TOWN).**

A new engine and boiler for moving the draw was put in place early in the year, and has furnished ample power for that purpose.

The settlement of the draw foundation continues to be a source of trouble and expense, and it will be necessary to rebuild a part of it during the coming year. The bridge as a whole is old, and in poor condition. No extensive repairs were made during the year.

**\*CHELSEA BRIDGE (SOUTH) (OVER SOUTH CHANNEL, MYSTIC RIVER).**

The lower track of the draw will require repairs in the spring, otherwise the bridge is in good condition.

The hand-power formerly used for turning the draw has been replaced by horse-power.

**\*CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

The part of this bridge between the draw and Chelsea, about one hundred feet in length, was destroyed by fire on September 7, and the draw was damaged to some extent.

The fire was caused by an explosion on board a schooner loaded with naphtha; its mooring ropes were burned off, and the burning vessel drifted against the bridge. The damages were repaired at a cost of about \$3,000. The draw is old, narrow, and badly decayed, and can be made to last but a short time longer. The bridge, excepting the draw, is in good condition.

**COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

There are several wire ropes attached to the trusses as stays to a telegraph pole which should be removed. Only ordinary repairs have been made, and the bridge is in fair condition.

**\*COMMERCIAL POINT, OR TENEAN BRIDGE (WARD 24).**

This bridge is in fair condition.

**COMMONWEALTH-AVENUE BRIDGE (IN BACK BAY).**

No repairs have been made on this bridge. It is in good condition.

**\*CONGRESS-STREET BRIDGE (OVER FORT POINT CHANNEL).**

A special appropriation of \$13,200 was made, for the purpose of repairing the draw pier, and protecting the foundation of the draw from the effects of deepening the channel by the United States government.

The work of doing the above repairs was done by Mr. F. G. Whitcomb, under a contract dated August 19, 1887.

The plank face of the pier and water-ways, with the protecting corner-irons, were removed, and two hundred and thirty additional oak piles, each forty-eight feet in length, driven. The face of the water-ways on both channels and the ends of the pier were planked with oak and maple plank, and the corner-irons replaced in good condition.

The total cost of the work was \$10,796.40.

The bridge has been painted, and ordinary repairs made. The fender is in bad condition, the upper ends of a number of the bridge piles are decayed, and a considerable amount of repairs to pile work will be required this year. The boilers which furnish steam for moving the draw are old and past repair, and it will be necessary to renew at least one of them during the coming year.

When the bridge was built, the end towards the city proper abutted upon Russia wharf, part of its width being upon the solid wharf, and part over the adjacent dock. As it was reasonably certain that the dock would be filled before many years, the widening was made upon a pile structure, to save the construction of an expensive retaining-wall. The dock and the vacant space under the bridge have been filled without expense to the city, and the bridge floor over this filled space should be removed, and the paving replaced upon the solid earth.

**DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND BOSTON & PROVIDENCE RAILROAD).**

The under floor of this bridge has been patched, and should be renewed the next time the bridge is sheathed; otherwise the bridge is in good condition.

**\*DOVER-STREET BRIDGE (OVER FORT POINT CHANNEL).**

One sidewalk has been replanked. The bridge is in fair condition.

**\*FEDERAL-STREET BRIDGE (OVER FORT POINT CHANNEL).**

This bridge was built in 1828, rebuilt and widened in 1858, again rebuilt and widened in 1873, and portions of the

structure date from each of these periods. The wooden draws built in 1873 are in such bad condition that expensive repairs will be needed to keep them in use another year, and when the repairs are made the structure will not be worth the money expended. The recommendations of the past three years is renewed, — that the bridge be rebuilt with a new iron draw of the full width of the bridge, to be moved by steam-power.

Only the repairs absolutely required have been made during the year.

**FERDINAND-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is a poor bridge; a portion of it is carried on posts, and the span over the railroad is composed of three iron trusses of two patterns, and two wooden trusses. It is narrow, inconvenient, and unsightly. The portion supported on posts should be filled solid, and a new bridge built over the railroad.

**FRANKLIN-STREET FOOT-BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is in good condition.

**HUNTINGTON-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

The under floor of this bridge has been renewed, the sidewalks replanked, and the bridge painted. It is in good condition.

**LINDEN PARK-STREET BRIDGE (OVER STONY BROOK).**

This bridge is in a good condition.

**\*MALDEN BRIDGE (FROM CHARLESTOWN TO EVERETT).**

This bridge has a wooden draw, built in 1872, which is old and weak. It will require some repairs during the coming year.

The bridge and pier are in fair condition.

**\*MERIDIAN-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

The sidewalks have been newly concreted, and the bridge has been painted. The lower track of the draw should be renewed, and a new set of wheels provided.

**\*MT. WASHINGTON-AVENUE BRIDGE (OVER FORT POINT CHANNEL).**

An appropriation was made for protecting this bridge against the proposed deepening of the Channel by the U.S. government; but, owing to the failure of the River and Harbor bill in Congress, the work of dredging has not been continued above Congress-street bridge, and consequently the money appropriated for repairing this bridge was not used. It is still intended at some future time to deepen the channel as far as Federal-street bridge, and before this is done these repairs will have to be made.

Only ordinary repairs have been made, and the bridge is in good condition.

**NEWTON-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This bridge is in good condition.

**PUBLIC GARDEN FOOT-BRIDGE.**

The wood-work has been renewed, the bridge painted, and the abutments and piers pointed, under specifications prepared in 1886.

The bridge is in good condition.

**SHAWMUT-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

A twenty-four-inch wrought-iron gas-pipe has been laid under the westerly sidewalk by the Bay State Gas Co. The iron-work of the span over the main tracks is in need of painting; otherwise the bridge is in fair condition. Like all the bridges over railroads, this one shows the effects of corrosion from the smoke of the locomotives. No paint yet used has been found to be proof against the action of these gases, and the iron of all the bridges over railroads is deteriorating more or less from this cause.

**SWETT-STREET BRIDGES (OVER SOUTH-BAY SLUICES).**

These bridges will require extensive repairs next year. They were intended, when built, to be only temporary structures, and are now in bad condition.

**\* WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).**

Only slight repairs have been required, and the bridge is in good condition, except that it should be painted.



**WEST CHESTER PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

The sidewalks are poor, the wood-work is in bad condition, and the iron-work needs painting. The bridge should be thoroughly overhauled, and made to conform to the street in profile.

**WEST CHESTER PARK BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This bridge needs painting; otherwise it is in good condition.

**WEST RUTLAND-SQUARE FOOT-BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This bridge is in good condition.

**WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP).**

Eighteen piles have been driven in this bridge to replace an equal number which had become seriously weakened by the *Limnoria terebrans*, or sea-worm. The piling was cross-braced, and the bridge is now in good condition.

**II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.**

**\* CAMBRIDGE-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The draw-pier needs replanking; otherwise the bridge is in good condition.

**CENTRAL-AVENUE BRIDGE (OVER NEPONSET RIVER, DORCHESTER LOWER MILLS).**

This bridge is in good condition.

**\* CHELSEA BRIDGE (NORTH, FROM MYSTIC-RIVER CORPORATION WHARF TO CHELSEA).**

The wooden draw is old, and will require some repairs. The bridge has been painted, and is now in fair condition.

**\* ESSEX-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The floor of this bridge has been put in good condition by replacing a large number of decayed stringers, relaying

the under floor and sheathing; the sidewalk and fence have also been renewed. The piles are small and old, and the bridge is too narrow to accommodate the large amount of travel over it. The widening of Commonwealth avenue will make a steep grade at the Boston end of the bridge, which grade, and the railroad crossing at the head of the bridge, will require the replacing of the bridge by an elevated structure, or its relocation.

**\* GRANITE BRIDGE (FROM WARD 24 TO MILTON).**

The draw is in bad condition, and will require repairs when navigation opens. The remainder of the bridge is in good condition.

**LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOK-LINE).**

This is a wooden trestle, and some of the posts are set in the ground. These have commenced to decay, and require attention. The roadway also needs repair, and the fence should be painted.

**MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).**

The recommendation made last year is repeated: "The bridge should be replaced by a stronger one" The bridge is a weak structure, and is in poor condition.

**MILTON BRIDGE (FROM WARD 24 TO MILTON).**

The wood-work of this bridge should be repaired during the low stage of the river, and the iron-work painted. The stone-work of a part of the bridge is in poor condition, but no change has been observed in it during the past year.

**\*NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).**

The up-stream pier has been replanked, and the down-stream pier is in need of it; otherwise the bridge is in fair condition. Notice has been given of an intention to petition the Legislature for an Act requiring the water-ways of bridges on this river to be thirty-six feet in width.

**\*NORTH BEACON-STREET BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This bridge is in good condition.

**\*NORTH HARVARD-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The abutment was badly shaken by the collapse of a sewer outlet, and is in bad condition. The bridge is in fair condition.

**SPRING-STREET BRIDGE (FROM WARD 23 TO DEDHAM).**

This bridge is in good condition.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The draw requires some repairs; otherwise the bridge is in good condition.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This bridge was repaired, and a new abutment built, in 1886. The draw is an inconvenient one, and it is difficult to pass vessels of large size; but the bridge as a structure is in fair condition.

**III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.**

**ALBANY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

The construction of the abutments of this bridge was described in last year's report. During the year the iron superstructure has been erected, the abutments have been pointed, the parapet set, and the approaches put in order.

The total cost of the work done by the city was \$20,226.92. The Boston & Albany Railroad Co., as per agreement with the city, built the south abutment, raised the grade of the approaches at the southerly end of the bridge, waived all grade damages, paid the city \$3,000, and will pay to the city one-half the cost of the future maintenance of the bridge.

\*CANAL BRIDGE (FROM BOSTON TO CAMBRIDGE).

\*PRISON-POINT BRIDGE (FROM CHARLESTOWN TO CAMBRIDGE).

\*WEST BOSTON BRIDGE (FROM BOSTON TO CAMBRIDGE).

These bridges are in care of two commissioners, one appointed by each city, and the expense of maintaining the bridges is borne equally by each city. The Boston Commissioner makes an annual report in print. (City Doc. 25, 1888.)

West Boston bridge is old, and narrow for the large amount of travel over it. The roadway and one sidewalk are in need of repairs, which the Commissioners contemplate making during the year.

Prison Point bridge is in fair condition. The paving on Canal bridge is in bad condition, and some of the piles which carry the bridge are very old and may require repairs at any time.

DORCHESTER-STREET BRIDGE (OVER OLD COLONY RAILROAD).

The iron-work is in need of painting ; otherwise the bridge is in good condition.

#### IV.—BRIDGES SUPPORTED BY RAILROADS.

Four bridges over the Dedham branch of the Boston & Providence Railroad have been rebuilt since the last report, namely, Bellevue avenue, Park street, Beech street, and Dudley avenue ; and the Centre-street bridge over the main road has been thoroughly repaired.

The bridge on Harrison avenue over the Boston & Albany Railroad has been partly rebuilt. The bridges over the same road on Washington street and Tremont street are in bad condition from the wasting of the iron from rust, and require immediate attention.

The other bridges given in the list of those supported by railroad corporations are in fair condition, and require no special mention.

## MISCELLANEOUS WORK AND CONSTRUCTION IN 1887.

### BOYLSTON-STREET BRIDGE.

The abutments for this bridge, begun in 1886, have been completed, at a cost of \$77,375.77. The general design and construction of these abutments are shown in the accompanying plate.

Plans for the superstructure of this bridge have been prepared, and it is expected that the entire work will be completed during the coming summer.

### WHARF AT LONG ISLAND.

Plans and specifications were prepared for a wharf at the north-westerly side of Long Island, and the work was let to McInnis & Parker, the lowest bidders. The work was completed July 23, and cost \$7,422.94.

The new wharf is built on the site of the old wharf, has berths for three vessels, and a depth of seven to eight feet of water at low tide at its outer end. It is of similar construction to the wharf built in 1886, on the opposite side of the island, and is provided with a movable drop for loading and unloading freight. The walls of the solid portion of the wharf have been partly rebuilt.

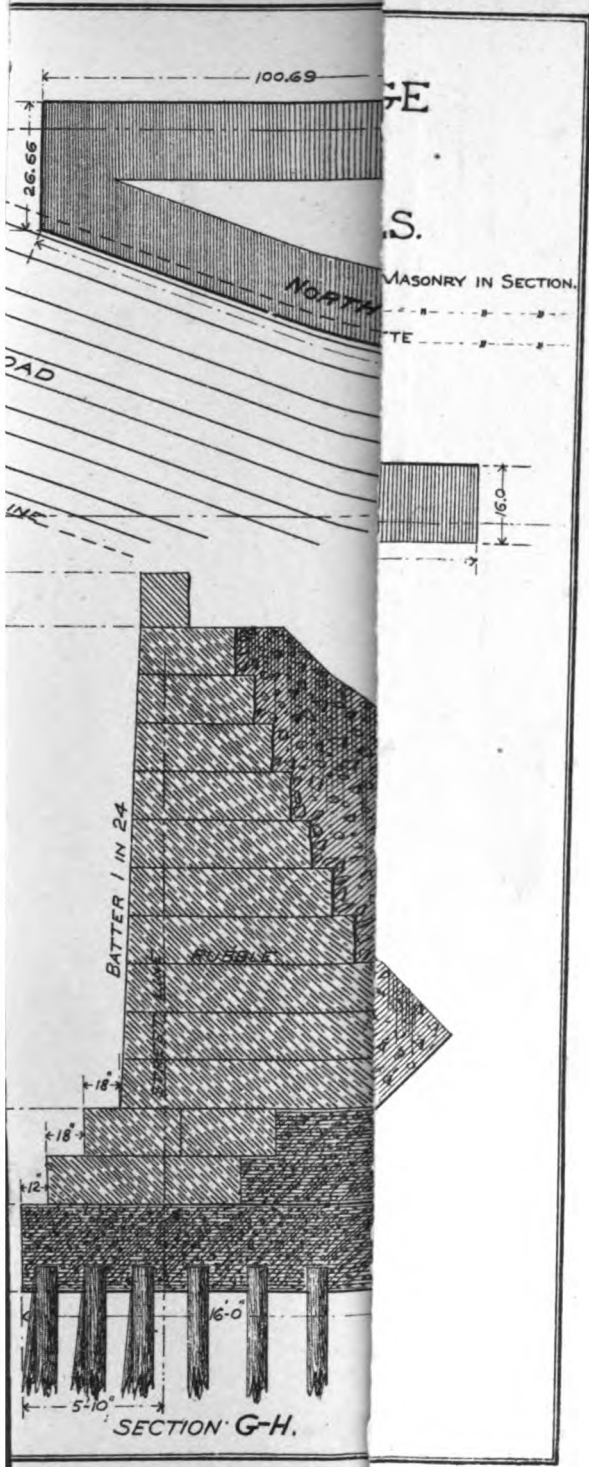
### QUINCY-STREET BRIDGE.

This is a railroad bridge over Quincy street, and an agreement has been made between the city and the New York & New England Railroad Company under which the bridge is to be built by the railroad company, in accordance with plans to be approved by the City Engineer, and the city is to pay one-half the cost of the work.

The abutments are nearly completed.

### PAVING WHARF.

Plans and specifications have been prepared for rebuilding the wharf at No. 521 Commercial street, recently purchased by the city for a paving wharf. The contract for building the wharf has been awarded to Benjamin Young. No work has yet been done.





## EAST BOSTON FERRIES.

Plans and specifications were drawn for rebuilding two piers of the slips for the South Ferry in East Boston, and the work was let to McInnis & Parker in September.

The piers are to be built with oak piles and faced with oak waling pieces and maple plank. One drop is to be taken out, three sets of guide piles driven and fitted, and slight changes made in the third pier, to better accommodate the boats.

The work will probably be completed in February.

## STATUE OF LIEF ERICSSON.

A concrete foundation for this statue was put in place, at a cost of \$221.95.

Other work of a miscellaneous character may be classed as follows :—

*Plans and Specifications.*

For Iron pier, Marine Park.

Water-pipe, Chestnut-hill avenue.

Boilers, steam-pipe, gates, etc., Chestnut-hill Pumping-station.

Iron roofs, Chestnut-hill Pumping-station.

Engine-house roof, Mystic Pumping-station.

Cumberland-street bulkhead.

Stone-crushing plant, Dorchester paving-yard.

*Estimates.*

For Bridge on Beachmont avenue.

“ “ Talbot “

New draw for Malden Bridge.

Works to abate nuisances at Pope's Hill stations in Dorchester, and at Germantown, Ward 23.

The usual large amount of work of a general character has been done during the year. Under this head may be classed record-plans, maps for Water-Works and Park Department, copying, tracing, and blue-printing plans.



## B. — WATER-WORKS.

## SOURCES OF SUPPLY.

The rainfall of the past year was somewhat below the average, but was quite evenly distributed throughout the year, so that there has been no scarcity of water at any time, and the storage reservoirs have been kept nearly full for the greater portion of the year.

Very little trouble has been experienced from the growth of algæ, and the quality of the water, with the exception of the Mystic supply, has been good.

The work of improving the shallow portions of Lake Cochituate by deepening certain portions and filling the margins in others, as was done in the Sudbury-river reservoirs in 1886, was commenced in September, and continued until December 20.

The work done was confined to the valleys of Course and Beaver-dam brooks, and a section near the Natick cemetery.

About 50,000 cubic yards of material was handled.

*Consumption.*

The daily average consumption of water from the combined works has been as follows:—

	Cochituate Works.	Mystic Works.	Total.
January . . .	32,687,600	10,488,600	43,176,200
February . . .	31,224,300	9,346,700	40,571,000
March . . .	28,124,100	8,175,000	36,299,100
April . . .	25,591,500	6,933,800	32,525,300
May . . .	27,925,000	6,916,300	34,841,300
June . . .	30,069,000	7,159,800	37,228,800
July . . .	30,469,000	7,250,000	37,719,700
August . . .	30,063,100	6,871,900	36,935,000
September . . .	31,946,600	6,868,600	38,815,200
October . . .	30,562,700	6,436,600	36,999,300
November . . .	28,062,000	7,361,200	35,423,200
December . . .	31,511,500	7,835,300	39,346,800
<hr/>			
Averages . . .	29,852,100	7,629,000	37,481,100

The daily average consumption per head of population has been as follows:—

Sudbury and Cochituate supply . . .	80.8 gallons.
Mystic supply . . . . .	72.7 “
Total supply . . . . .	79. “

The above figures show an increase in the consumption of the Sudbury and Cochituate works of 12.1 per cent. over that of the year 1886; of the Mystic works of 3.1 per cent., and of the combined supplies of 10.1 per cent. The increase on the Sudbury and Cochituate works has been larger than the probable increase in population. Although the number of premises supplied through meters has been reduced, there has been a large increase in the amount of metered water used, amounting to an increased daily consumption of 856,500 gallons of metered water,—about 13 per cent. over that of the year 1886, the metered water used in 1887 being at the rate of 7,229,700 gallons daily. Should allowance be made for the fewer premises metered, the percentage of increase would be higher. The fact that the number of new service-pipes laid during the year has been larger than for any year since 1871 furnishes another reason for a large legitimate increase in consumption.

#### NEW HIGH-SERVICE WORKS.

These works are approaching completion, and within a few weeks the pumping-stations at Roxbury and Brighton will be abandoned, and the new works placed in service. Plans for the pumping-station at Chestnut Hill were being prepared during the latter part of 1886, and, in order that work upon the masonry might be begun as soon as the season would permit, the excavations were begun on January 10, and continued until March 31, under the direction of Mr. Fitzgerald, Superintendent of the Western Division. Plans and specifications were prepared for the foundations for the building and engines, together with the chimney, pump-wells, screen, and connection chambers, and on March 2 a contract was executed with Collins & Hain for doing the work. They began active operations on April 1, and completed their contract on September 9. A contract for the masonry of the superstructure was awarded to Donahue Bros. on April 5, and on June 27 they commenced work on the erection of the building.

The walls of the building are now nearly completed, and the contractors for the iron roofs are erecting the trusses for the coal-shed and boiler-house. On May 6 a contract was made with George Miles, for furnishing and setting two

boilers, and they are now set, and covered by a temporary wooden building. The first shipment of the Gaskill engines arrived on August 16, and the work of setting up the machinery has been in progress during the past four months. One engine is now ready to be started, and the second engine will be completed in a few weeks. The engines have been covered by a temporary wooden building to facilitate erection, and in order that they may be used before the completion of the permanent building.

The laying of the force main and the connections with the pumps have been completed by the Superintendent of the Eastern Division.

During the winter of 1886-87 Fisher-Hill reservoir, though uncompleted, was partially filled with water for the purpose of protecting the completed work from the frost. On April 8 the waste-gate was opened, and on April 21 the reservoir was empty.

Work was resumed by the contractors, Moulton & O'Mahoney, on April 27, and was continued by them through the season, until November 18, when their contract was completed.

On November 30 the sluice-gates at the gate-chamber were finished, and the water was let into the basin, reaching high-water mark on Jan. 6, 1888. The following description and plates show the construction of this reservoir : —

The reservoir is rectangular in shape, 500 feet by 295 feet, measured at the top of the inner slope of the embankment, and 423 by 218 feet at the bottom of the slope. The high-water mark is 241 feet above tide-marsh level; the top of the earth embankment 245 feet; the foot of the inner slope 223 feet; the centre of the reservoir 221 feet, and the invert of the 36-inch pipe 220 feet. The reservoir is built partly in excavation and partly in embankment. The embankment is 20 feet wide on top, with outside slopes of 2 horizontal to 1 vertical, and inside slopes of  $1\frac{3}{4}$  horizontal to 1 vertical. It is composed of the material from the excavation, a compact, clayey gravel spread in 4-inch layers, watered and thoroughly rolled. The inner slope of the embankment is covered to above the high-water line with a layer of puddle 2 feet in thickness, composed of the natural material, from which all the large stones were removed, and brick clay, thoroughly mixed in the proportion of  $\frac{2}{3}$  natural material and  $\frac{1}{3}$  clay, wet and rammed in place. This puddle is covered from the base of the slope to grade 235 with a layer of Portland cement concrete 9 inches in thickness. Between

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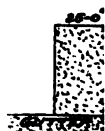


VEL WALA  
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**15,550,804**



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grade 235 and 243 the slope is covered with a paving of Roxbury stone 15 inches in thickness, underlaid by 12 inches of small broken stone.

To prevent any slipping of the puddle or of the paving on the slope, an abutment of American cement concrete is placed at the foot of the slope, as shown on section. The bottom of the reservoir is covered with 2 feet of puddle, composed of the natural material mixed in thin layers with a small quantity of clay, wet and rolled. For a distance of 10 feet from the foot of the slope the bottom is covered with a layer of Portland cement concrete 6 inches in thickness. The bottom slopes toward the centre, and is drained by a concrete gutter to the gate-chamber. The outer slope of the embankment is covered with loam 2 feet in thickness, there being a surplus of loam from the excavation. A gravel walk 8 feet in width surrounds the reservoir on the top of the embankment. The gate-chamber is located in the centre of the easterly embankment. It is 20 feet by 20 feet 10 inches, inside dimensions, with side-walls of rubble granite masonry 26 feet high, 5 feet 6 inches thick at the bottom, and 3 feet 6 inches at the top, and is divided by brick partition walls into influent and effluent chambers, as shown on the accompanying plate. The foundation course is a bed of American cement concrete 2 feet thick, and below this there are three cut-off walls of concrete 2 feet square, running parallel with the centre line of the embankment, designed to cut off leakage. The water enters the gate-chamber through a 36-inch pipe, passes out through a 36-inch pipe, and enters the reservoir near the centre. A brick division wall, with sluice-gate at the bottom and stop-planks above, prevents the reservoir from being emptied in case of a break in the force-main. By means of two sluice-gates in the effluent chamber water can be taken from different depths. The pipe for overflow and drainage is 16 inches in diameter; it is reduced to 12 inches outside of the reservoir, and carried down Fisher avenue to Boylston street, there connecting with a surface drain. The drain from the reservoir of the town of Brookline is also connected with this pipe. The superstructure of the gate-house is brick, with trimmings of Longmeadow brown-stone. The work is now complete with the exception of some grading and sowing of the grounds, which will be done in the spring.

The total cost of this reservoir to date is as follows : —

Land . . . . . \$92,042 00

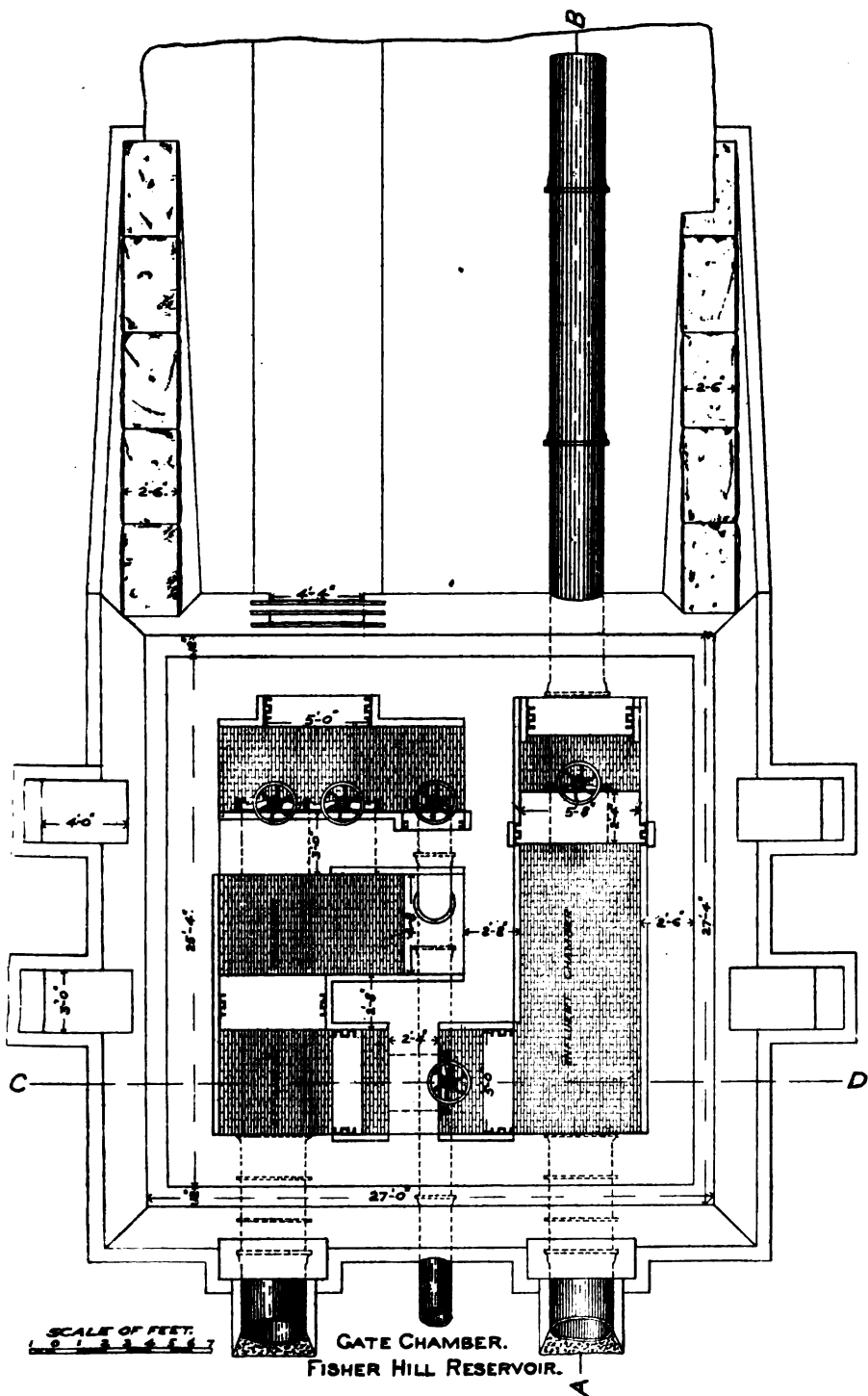
Construction of reservoir : —

81,095 cubic yards earth excavation,	\$33,248 95
97 " " rock " "	121 25
2,476 " " clay delivered .	6,315 80
5,566 " " slope puddle .	3,005 64
6,429 " " bottom " .	3,085 92
2,155 " " ballast in place .	5,387 50
561 " " American cement concrete .	3,096 72
1,350 " " Portland cement concrete .	10,287 00
139 " " brick masonry .	1,390 00
394 " " rubble " .	3,546 00
1,104 " " slope paving .	3,941 28
21.2 " " dimension masonry, 6-cut .	805 60
37.7 " " dimension masonry, quarry face .	848 25
139 lineal feet 36-inch pipe laid,	37 53
42 " " 16-inch " " .	6 30
141 cubic yards granite slope paving .	554 13
Extra labor and materials .	289 40
Total paid Moulton & O'Mahoney .	75,967 27
Sluice-gates, etc. .	1,215 00
Gate-house superstructure .	8,912 00
Miscellaneous ; including engineering, advertising, office, etc. .	9,948 35
Total cost of reservoir .	<u>\$188,084 62</u>

The total amount expended from the appropriation for new high-service on January 1, 1888, was \$464,981.86, of which \$31,330.82 was expended for the West Roxbury high-service.

Plans and estimates have been made for high-service works to supply the high lands of Breed's Island, the construction of which was authorized by the City Council. A wrought-iron tank will be erected on the summit of Breed's Hill, to which water will be forced by pumps located at the present pumping-station near the reservoir.

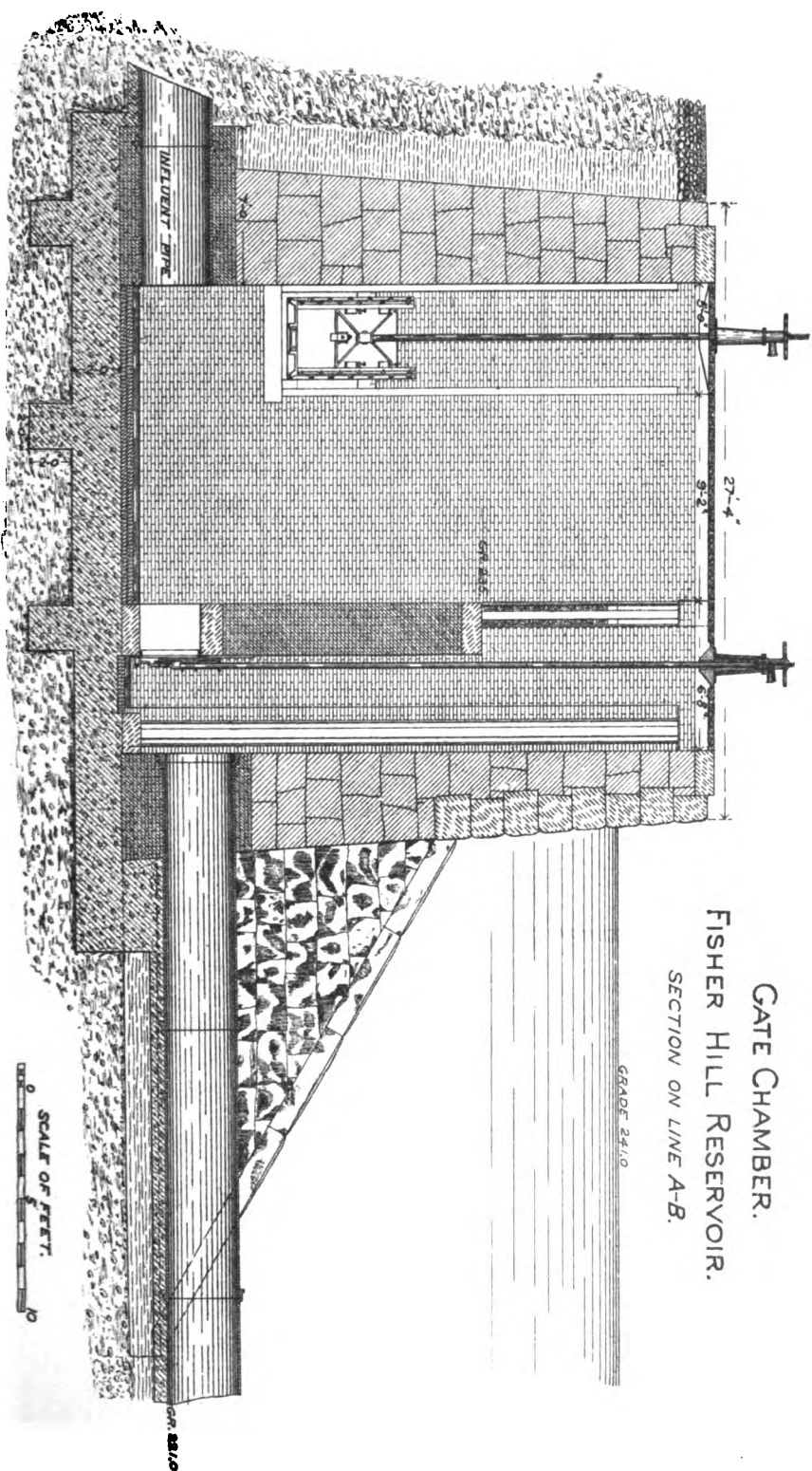
The work can be commenced as soon as the weather will permit.



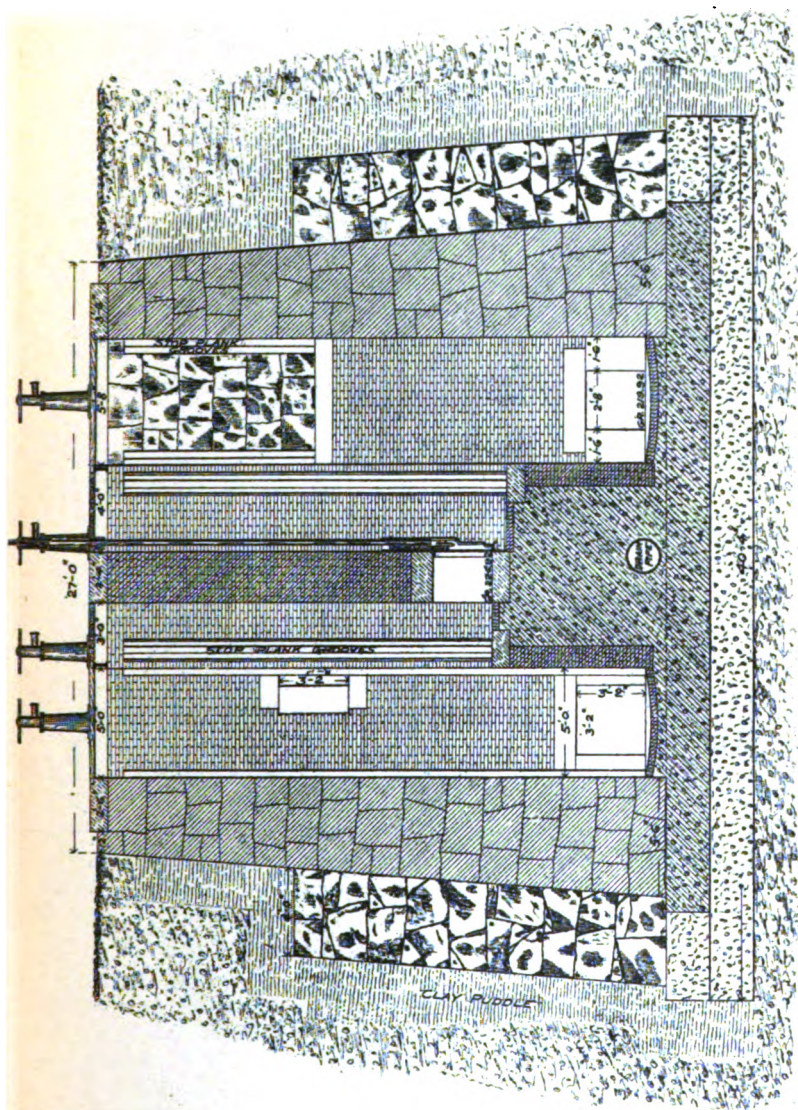




GATE CHAMBER.  
FISHER HILL RESERVOIR.  
SECTION ON LINE A-B.







GATE CHAMBER.  
FISHER HILL RESERVOIR.

SECTION ON LINE C-D.

SCALE OF FEET.  
10 5 0



## DISTRIBUTION.

The total length of pipe laid on the Sudbury and Cochituate works was 24.68 miles; of this amount 2.32 miles were laid to replace pipes existing which were relaid for various reasons, making a net increase in the total length in use of 22.36 miles. This is the largest amount of pipe laid on the Sudbury and Cochituate works since 1875. On the Mystic works the mains have been extended 23,762 feet, and 9,928 feet of wrought-iron and cement pipe have been replaced by cast-iron pipes. The Cochituate distribution has been also greatly improved by removing the tubercles from the old 6-inch and 12-inch mains, by means of the Sweeney pipe-scraper. In the City proper, South and East Boston, there were cleaned during the year 40,932 feet of 6-inch and 20,280 feet of 12-inch pipe, at an average cost of 13.7 cents per foot for the 6-inch, and of 20 cents per foot for the 12-inch.

An order of the City Council, approved May 28, 1887, authorized the laying of a new main for the improvement of the East Boston supply, and a contract was made on June 11, with R. D. Wood & Co., for 1,100 tons of 24-inch pipe at \$35, and 170 tons of 30-inch pipe at \$34.50, per gross ton. In July the City Council authorized the laying of pipes for the supply of Charlestown from the Cochituate works. As the new main to East Boston was to be laid through Charlestown, the original plan for the East Boston main was modified by enlarging the size of the new main between the City proper and Charlestown, and connecting it with the large mains on the Common instead of with the 24-inch at Haymarket square. On September 21 a contract for 1,280 tons of 16-inch and 30-inch pipe, at \$30.69, was made with the Gloucester Iron Works. The contract of R. D. Wood & Co. has been completed, and 5,356 feet of 24-inch and 1,256 feet of 30-inch main laid in Charlestown and on Chelsea bridge. In connection with this work the bridge which carries the water-pipe across the Mystic river has been rebuilt. This bridge was built in 1850, and the boxing rebuilt in 1867, when the Mystic works were extended to Chelsea. The boxing and fender-guard were very badly decayed. The contract for doing this work was made with J. N. Hayes & Co., on August 29, for the sum of \$14,500. The old piles were cut down and spliced in a substantial manner, with 10 by 12 inch hard-pine sticks. Three 10 by 14 inch longitudinal stringers, supported by 6 by 12 inch double girder caps, are bolted to the tops of the spliced piles; a flooring of 4-inch spruce plank is laid

upon the stringers, making a platform  $8\frac{1}{2}$  feet in width, on which are laid the 16-inch and 30-inch pipes. The pipes are covered by a housing large enough to be entered for examining and repairing the pipes. The new fender is placed 16 feet from the bridge, so as to provide a protection against injury from vessels.

The relocation and change of grade of Beacon street, in the town of Brookline, has necessitated the relaying of 1,528 feet of the 48-inch main, and there are other portions of the main which will require lowering during the coming season.

The sea-wall at the Albany-street pipe-yard has been rebuilt by Boynton Brothers, at a cost of about \$10,500. The old wall was taken down, additional piles driven, and the wall rebuilt, using new stone for the face, and also for a substantial cut-stone capping. On the face of the wall is an oak-pile fender with hard-pine cap. Examinations and estimates have been made of the cost of supplying the public institutions on Long Island with Cochituate water.

### C. — MAIN DRAINAGE WORKS.

This work was put into operation in January, 1884, and has been in continuous use since that date.

The service rendered by the system has equalled the expectations of its designers, and it has accomplished all that was claimed for it. The removal of the sewage from the portions of the city embraced by the system has greatly improved docks and flats within their limits which were formerly exceedingly offensive, and were yearly becoming more of a nuisance; but, while Boston has taken care of its pollutions, Cambridge and Brookline still continue to pour a yearly increasing volume of sewage into the Charles-river basin, and if they are allowed to continue to do so will in time reproduce in this section of the city a nuisance already once abated.

The State Board of Health is now considering the subject of the disposal of the sewage from the territory contiguous to Boston and of certain sections of the city not embraced by the Main Drainage Works; and it is hoped that their labors will bring tangible results in the near future.

In compliance with a vote of the City Council, passed December 31, 1887, the maintenance of these works was transferred to the Sewer Department, January 2, 1888.

The construction work of the past year included the completion of Section 6, South Boston intercepting sewer, the contract for which was signed in 1886; the replacing of the

rip-rap about the eastern shaft of Dorchester-bay tunnel; a connection with Stony brook at Clay street; the building of blocks at Old Harbor Point, in which to run the tow-boat and sludge scows to make repairs; the laying of water-pipe on the line of the tank sewer; the bulkhead at Lowland street, South Boston; the placing of an iron fence around Moon Island reservoir and of a crane on the wharf.

There is much work remaining to be done that will facilitate the economic maintenance of the work, and it should be done at an early day.

The average daily amount of sewage pumped for the years 1885, 1886, and 1887 is shown as follows:—

	* Daily Average of Sewage Pumped, in Gallons.		
	1885.	1886.	1887.
January .	39,016,276	41,063,812	58,648,433
February .	45,593,905	60,612,617	53,827,805
March .	35,095,506	39,774,669	52,857,787
April .	28,700,863	36,725,288	50,431,531
May .	30,306,228	32,157,392	36,214,703
June .	29,931,484	26,625,076	40,631,019
July .	29,642,964	31,743,685	38,172,331
August .	36,996,434	32,326,434	38,881,361
September .	28,761,290	32,903,724	35,777,621
October .	31,476,179	33,395,604	37,330,106
November .	38,917,253	34,170,833	37,134,588
December .	32,894,281	40,894,411	43,660,600
Average .	33,874,575	36,866,129	43,630,657

Maximum daily amount pumped in 1887, 116,972,611 gallons

Minimum daily amount pumped in 1887, 27,796,176 gallons.

#### COST OF PUMPING.

Labor .		\$17,334 96
Coal .		8,687 48
Water .		711 60
Valves .		838 82
Gasoline .		529 05
Oil .		500 22
Packing .		198 61
Waste .		49 12
Renewals, repairs, etc. .		3,316 84
		<hr/>
		\$32,166 70

Cost per million gallons lifted one foot high, \$0.0585.



### MAIN AND INTERCEPTING SEWERS.

In addition to the regular inspection of the gates, regulators, and other appurtenances, a large amount of work has been done by the regular force, removing from the sewers deposits of gravel, and scraping from the side walls accumulations of grease. The sewers are at present remarkably free from all deposits, and all the iron-work has been thoroughly cleaned, repaired, and coated.

Considerable work has been done, moving over and changing the elevation of man-holes, necessitated by laying of horse-railroad tracks and the regrading of streets.

The connection made at Clay street with Stony brook in case of a freshet will allow it to overflow into the Cabot-street intercepting sewer.

The bulkhead was built at Lowland street, South Boston, to hold the filling for the roadway; this was done in accordance with an agreement made for the right of way.

The overflow sewers at First and Livingstone streets, which were cut off by the construction of the Charles River Embankment, ought to be extended, as the capacity of the overflow in that district is comparatively small, and a freshet might cause considerable damage.

The office accommodations at the Main Drainage yard on East Chester park are inconveniently small, and a more suitable office should be provided as soon as funds can be spared for this purpose.

### SECTION SIX, SOUTH BOSTON INTERCEPTING SEWER.

This section was completed and connected with the system in October.

### PUMPING-STATION.

The pumping machinery is in good working condition. The following table shows the performance of the engines at the pumping-station during the year 1887: —

**MAIN DRAINAGE PUMPING-STATION.**  
*Report of Pumping done during the Year 1887.*

1887.	ENGINE 1.		ENGINE 2.		ENGINE 3.		ENGINE 4.		Total amount pumped.	Daily average pumped.	Daily average amount of coal used.	Per cent. of sales and clinkers.	Gallons pumped per lb. of coal.	Average lift.	Duty in foot-lbs. of coal.	Rainfall.
	Pumping time.	Gallons.	Pumping time.	Gallons.	Pumping time.	Gallons.	Pumping time.	Gallons.								
January . . . . .	147 05	168,325,957	98 05	113,162,031	560 42	666,277,452	724 42	872,335,960	1,818,101,420	58,648,453	18,030	10.3	3,253	34.45	93,782,801	6.01
February . . . . .	39 47	44,152,846	71 22	82,086,352	618 00	771,470,784	504 50	609,468,552	1,507,178,534	53,827,805	15,196	10.1	3,542	34.20	101,385,783	4.43
March . . . . .	78 48	93,927,271	38 05	44,922,700	685 32	848,333,288	537 54	651,408,156	1,638,591,404	52,857,787	14,913	10.6	3,544	33.95	100,706,454	4.60
April . . . . .	38 20	41,968,868	85 35	41,216,592	536 38	647,902,332	654 10	781,868,124	1,512,945,916	50,431,531	13,894	12.2	3,630	34.60	105,105,278	3.48
May . . . . .	6 15	7,018,106	8 20	9,812,473	281 13	341,826,300	620 53	763,998,912	1,122,655,791	36,214,703	10,460	17.4	3,462	34.65	100,399,153	2.14
June . . . . .	4 30	5,277,374	23 30	27,544,292	708 03	905,710,680	253 25	280,398,240	1,218,930,586	40,631,019	11,687	11.4	3,476	34.50	100,388,683	2.03
July . . . . .	19 50	23,363,908	24 43	27,405,682	339 57	417,480,606	589 14	715,001,976	1,183,342,262	38,172,351	11,326	12.3	3,370	34.88	98,383,477	4.26
August . . . . .	24 23	29,128,686	37 25	45,605,865	414 02	522,235,900	506 31	608,351,832	1,205,322,183	38,881,361	11,768	11.4	3,304	34.69	95,921,655	3.38
September . . . . .	3 30	4,285,485	30	568,858	341 50	422,673,441	531 05	645,800,868	1,073,328,655	35,777,621	10,393	11.1	3,472	34.70	100,844,171	1.24
October . . . . .	17 50	21,758,493	16 13	19,462,041	471 07	595,540,008	425 21	520,472,736	1,157,283,278	37,330,106	10,693	11.4	3,520	34.40	101,359,036	2.58
November . . . . .	15 50	19,112,580	20 51	25,195,290	516 49	651,902,226	347 00	417,827,556	1,114,037,646	37,134,588	10,684	11.7	3,476	34.80	101,227,274	2.14
December . . . . .	29 35	35,350,851	35 30	43,118,917	671 20	840,441,528	361 25	425,558,394	1,363,478,600	43,660,600	13,261	10.8	3,285	34.56	95,227,136	3.02
Totals and averages	425 43	401,690,425	410 09	480,191,102	6,143 33	7,640,764,512	6,036 30	7,292,491,226	15,905,146,275	49,630,657	12,677	11.7	3,444	34.53	99,560,914	39.40

Several minor additions to the plant have been made during the year, and a few changes were also made, all of which have proved beneficial.

A machine-shop has been fitted up in the engine-house, consisting of an engine, a planer, a lathe, a drilling-machine, and a grindstone. By means of this shop a large amount of machine work has been done by the employees, which otherwise would have had to have been sent to a shop, the expense and inconvenience of sending being often more than that of doing the work. Blocks have been put up, by the means of which ordinary repairs can be made on the two boat and sludge scows. The grounds have been enclosed by a tight board-fence, and the temporary office has been fitted up as for permanent use; it is heated by steam.

The force employed on construction was discharged in April. Plans for a new building, to contain a stable and tenement for the teamster, have been made by the City Architect. It should be constructed during the coming year.

The flooring in the engine-house should be laid, and the balconies around the Worthington pumps put up, to give the room a finished appearance. There should, also, be an iron grating placed at the easterly side of the pumps in the engine-house.

#### DEPOSIT SEWERS.

A water-pipe has been laid in the embankment over the deposit sewers to furnish water for the sludge-carrier engine, and watering the embankment during the dry weather in summer.

By changes made in the sludge-tank, and by increasing the size of the pipe leading to it from the deposit sewers, and with the increased efficiency of the new "scraper," the cost of delivering the sludge to the scows has been decreased about forty per cent. A sludge scraper and carrier for the southerly deposit sewer, similar to those in the northerly one, should be built at once, and a permanent building erected over the engine.

Considerable difficulty has been encountered in towing the sludge scow outside during rough weather, which could be overcome by fitting the scow with a round bow. A new boiler is needed in the tow-boat, as the steam pressure allowed on the present one is not sufficient to work the boat to the best advantage.

A coal-shed built on the wharf at the pumping-station would save labor in handling the coal used on the tow-boat.

The following table shows the amount of material in the deposit sewers at the commencement of the year, the quantity received and the quantity removed from them during the year : —

Month.	Received cub. yds.	Removed cub. yds.
January . . . . .	1,270	69.86
February . . . . .	200	Shut down for alterations.
March . . . . .	185	139.71
April . . . . .	280	482.91
May . . . . .	240	368.24
June . . . . .	160	505.29
July . . . . .	480	496.61
August . . . . .	450	512.40
September . . . . .	390	672.65
October . . . . .	380	605.34
November . . . . .	510	523.02
December . . . . .	390	601.55
Total . . . . .	4,935	4,977.58

### TUNNEL.

The last test made to ascertain the condition of the tunnel showed it to be clearer than at the previous test.

The contract for placing rip-rap about the middle shaft has been finished.

The erection of the pumps at the last shaft should not be longer delayed.

The risk run, in having no facilities for pumping out the tunnel in case of any accident to it, is a sufficient reason for urging an appropriation for at least placing in position for use the machinery purchased several years ago for that purpose.

### FLUME.

The top planking of the flume has been re-spiked from above for its entire length, as it was found to be insecure ; the original spikes having been almost entirely rusted away by the sewage.

There has been some settlement during the year, and when four pumps were running there was considerable leakage ; but the flume has been wedged up, to the proper grade and the tie rods drawn up, so that the leakage is comparatively small. It is at present in very fair condition, and will stand a year or two longer if no undue strain is brought upon it.

## MOON ISLAND.

The regular force has been employed through the year, and the work has gone on smoothly. Iron stairways with posts and rails have been constructed in the engine-house, the gate-house, and to all the divisions of the reservoir. Parts of the turbine-wheel which were badly rusted and worn have been renewed. A crane has been erected on the wharf to facilitate the landing from vessels of coal and other supplies. The copper roof covering of the buildings being acted upon by the gases from the sewage, it has been protected by two coats of roof-paint. Other portions of the buildings were painted when necessary for preservation. Considerable pointing has been done in the discharge sewers and on the reservoir walls, and about a week's work grading the embankment where it had been washed by storms.

The wharf should be extended to deeper water, as the tow-boat cannot haul up to it after half-tide. The temporary wharf, built for construction, has been used; but it is badly rotted, and is liable to be carried away at any time. A permanent store-house and tenement for the use of the men employed on the work should be constructed, and the old buildings removed, as they are unsightly and insufficient.

The following is a statement of the condition of the appropriation for Improved Sewerage, January 1, 1888:—

## CONSTRUCTION.

Total appropriation . . . . .	\$5,480,444 93
Transfers by City Council . . . . .	67,500 00
	<hr/>
	\$5,412,944 93
Total expenditure . . . . .	5,392,407 28
	<hr/>
Unexpended balance . . . . .	\$20,537 65

The available balance is about \$6,000 less than this, by the amounts due, under existing contracts, on outstanding bills.

## MAINTENANCE.

Appropriation for 1887-88 . . . . .	\$70,820 00
Expended to January 1, 1888 . . . . .	49,243 59
	<hr/>
Balance unexpended . . . . .	\$21,576 41

## D. — PARKS.

For the purpose of making this report a complete record of the work of this department the following statement, which was made to the Park Commissioners, and printed in their report to the City Council, is given : —

## THE PARKWAY. — BACK BAY FENS.

*Excavation of Waterway.* — Upon the passage of the appropriation for Park Construction work was at once begun putting in order the dredging-plant, which, having been use for five years, needed extensive repairs.

Early in April the excavation of the waterway through the marsh at the southerly end of The Fens was resumed. This work has been continued through the season, and the waterway completed as far as the location of the proposed bridge at the junction of the Fenway and Audubon Road. Work in this direction can go no further until the additional land required between this point and Brookline Avenue is secured, as the material to be excavated from the waterway will be needed for filling on the Parkway and cannot now be disposed of without encroaching upon private lands. Unless this work can go on during the next season the dredging-plant will have but a few weeks' work to do.

In addition to the above, a large amount of work was done in trimming up portions of the shores, and of the bottom of the basin, which had been passed by in previous seasons.

*Grading of Marsh.* — The grading of the large area of marsh north of Agassiz Road has been completed, the area graded the past season being 7.6 acres. A portion of this area has been covered with marsh-sods cut from the old marsh, and the balance of the area is to be seeded with marsh grasses. The material for grading was excavated by the dredger, loaded on scows, and unloaded and moved into place by wheelbarrows. On account of the long distance a large part of the material had to be moved over soft ground the work has been slow and expensive.

*Drainage.* — Drains and catch-basins have been built in all that part of the Parkway north of Agassiz Road. The length of drain laid has been 2,700 feet, the number of man-holes built 5, and the number of catch-basins, 26. The drains on Boylston Entrance, and on the street between Boylston Entrance and the B. & A. R.R., discharge into a sewer built by the Sewer Department in 1886. The other drains, on the east side of the Parkway, discharge into the covered channel of Stony Brook, except two catch-basins on the ride, which have an outlet into the waterway.

The drains on the west side of the Parkway discharge into the waterway at a point about 250 feet north of Agassiz Bridge. An outlet for the drains to be built on Agassiz Road has been constructed.

Man-holes have been built at every change of line and grade, and catch-basins have been built on each side of the roadway about 300 feet apart.

The accompanying drawings show the forms of catch-basins built.

*Roadways and Walks.* — The curbstones were set and gutters paved on a part of the roadway in 1885. In addition, during the past year, 8,849 lineal feet of curbstone have been set, and 3,953 square yards of gutters paved. 3,600 lineal feet of curbstone and about 32,000 paving blocks are on hand.

The grade of Boylston Entrance was raised to meet a change in the established grade of Boylston Street; the curbstone and gutters were taken up, the entrance filled to the new grade, and the curbstone reset and gutters repaved. The roadway from Commonwealth Avenue to Westland Avenue and the roadway at Boylston Entrance have been finished.

The roadway of the west side of the Parkway from the B. & A. R.R. to Agassiz Bridge has been nearly sub-graded, and about one-half of it is stoned, so that, the curbstones and gutters being in place, but little work is needed to complete this section. The completion of Agassiz Road has been delayed on account of the bridge not being completed in season to allow the old channel across the road to be filled. The bridge is now so far finished that it can be used, and the curbstone being on hand for this road it will take but a short time to complete it after the next season opens. The roadways have been constructed in the following manner: The roadbed was carefully graded to 8 inches below the surface of the finished road and thoroughly rolled. The curbstones were first set; the gutters were paved with rectangular granite blocks, for a width generally of 4 feet, the blocks being laid in rows at right angles to the line of curb; the surface of the paving at the curb is 7 inches below the top of the curb, and rises 2 inches in the width of 4 feet. The roadway was then covered with broken stone; the stone was broken to sizes about as follows: for the first 4 inches in depth about 4 inches in diameter; then 3 inches in depth 2½ inches in diameter; then 1 inch in depth about 1 inch in diameter; then a layer of screened gravel or fine stone screenings from the crushers was spread on top; each layer was watered and rolled with 24-ton sectional grooved rollers. The surface of the roadway has a fall from the centre to the gutter of 1 in 30. The above-described method of road construction is cheaper and less substantial than would be desirable if the conditions were different. It must be understood, however, that the land upon which the roads are built has been but recently filled, and the filling is still settling, and will continue to do so for some years. A roadway prepared as this has been will last until the filling has reached a firm bearing, when it will be necessary to regrade the surface, and a more enduring foundation can be laid if desired. There is, on the other hand, this to be said in favor of a cheap method of construction in this locality, — that the filling being of loose gravel and the surface of the roadway being at all points several feet above the level of the ground water, the subsoil will be well drained, and a light covering of road metal will wear much better than it would under less favorable conditions. Nearly all of the stone used has been purchased by contract, and of such a size as could be received by a stone-crusher. It was suggested at the beginning of the season that the amount of stone received could be more accurately ascertained if it was purchased by weight instead of by the more usual method of measurement in carts. Experience has confirmed this opinion. Scales were set up near the Westland Entrance, and all stone purchased has been weighed.

A stone-crushing plant was purchased and set up near the same point, and the stone has been crushed at a less price than the same could have been purchased, and the rate of crushing has been controlled to suit the work in hand better than if it had been done by private parties.

The Water Department have, during the year, laid the mains which will be required on those parts of the Parkway where work has been in progress, so that, except for making house connections with the water-mains, there will be no occasion for disturbing the road-bed. It is supposed that the sewers and gas-pipes for this district will be laid in the back passageways, and not in the Parkway.

The ride from just east of the Boylston Bridge, along the east side of the Fens, has been completed as far as Agassiz Road. Where it borders the driveway it is separated therefrom by gutters 4 feet wide, paved

in a dishing form; at other places there are cobblestone gutters on either side. The ride was constructed by subgrading to one foot below finished surface; it was then filled to grade with gravel, from which all stones larger than three-quarters inch in diameter had been separated by screening.

Gutters of concrete were laid on each side of the foot-path between the ride and the water.

The walk on the easterly and northerly sides of the drive between Commonwealth Avenue and Boylston Entrance has been paved with brick; walks in other places have been graded, and a small portion finished by making a surface of 5 inches of crushed stone, the upper inch being of fine screenings, and the whole thoroughly watered and rolled.

The accompanying sketch shows the construction of the walks, drive, and ride.

*Agassiz Bridge.* — Early in the spring plans were prepared for a deck bridge with stone abutments, but it was afterwards decided to build a bridge of an entirely different character. The change was made so late that, on account of the work of park construction having been resumed, the time of the engineering force was so occupied that there was some delay in preparing new plans and specifications.

On the 22d of July proposals were advertised for the building of this bridge, and the contract for doing the work was signed on August 16. Work was begun immediately upon the excavation for the foundation. This work was done by the city, the dredging-plant being used, as it could be done in this way more cheaply and quickly than if it had been included in the contract. Dams of mud and gravel were built across the channel to enclose the site of the bridge. The contractor began work on September 22, and at this date his work is completed, except removing the centres from the arches and cleaning the brick-work.

The bridge consists of five semi-circular arches, the middle arch having a span of 12 feet; those on either side of the middle, spans of 10½ feet, and the outer arches, spans of 9 feet. The wings are returned on lines nearly parallel with the roadway. The foundation is a 4-inch spruce platform supported on spruce piles, capped with 10 in. × 10 in. spruce caps; a line of sheet piling is driven across each end of the platform.

Granite masonry abutments and piers, in courses of 2-feet rise, were built on this platform to the spring line of the arches. The arches, except at the ends, are of brick, the middle one being 16 inches in thickness and the others 12 inches in thickness. The ends of the arches are of Roxbury stone boulders, dressed sufficiently to make good radial joints, the exposed faces being left in their natural condition. The voussoirs are laid in cement; but the spandrels, the wall above the arches, and the wing-walls above the level of the water are of selected Roxbury stone boulders, laid dry, with pockets of loam between and behind them so that vines or small shrubs can be grown over the face of the wall. The walls have considerable batter, the cross-section having a curved profile. The line of the wall is on a curve, and above it the bank will slope upwards to the line of the walk, where there is to be a low parapet. Over the middle arches, on either side of the bridge, small bays will be built out from the walk. This work, with the exception of the parapet walls, will be completed in a few weeks. The stone for the face walls was brought from Franklin Park, having been taken from old field fences. The arches and abutments have been back-filled, and as soon as the ice breaks up in the spring, so that the dredger can work, the dams will be removed, and the present channel across the road filled to grade.

*Loaming and Planting.* — Quite a large area in detached portions, including spaces for trees between the walks and drives, have been



graded with loam, and a considerable amount of planting has been done under the immediate direction of the Assistant Landscape Gardener. A force of gardeners and laborers has also been employed throughout the season, under his direction, in the care of the plantations.

#### ARNOLD ARBORETUM.

Work was resumed here on February 3, quarrying stone for the drive-ways. This was continued until the frost was sufficiently out of the ground to allow work on the drives. The drive to the summit of Bussey Hill was partially sub-graded in 1885. This work was continued and completed late in the fall. The grading of the top of the hill required the moving of a large amount of material, and, as it was all moved up-hill, it was expensive. The grading of the lower part of this drive, near its juncture with the drive around the hill, furnished a large amount of material, which was used for filling the drive across the small pond in rear of the college buildings.

The drive was constructed in the following manner: The roadway was sub-graded so as to allow a depth of one foot for stone, the surface having a pitch of 1 in 20 from the centre to the gutter.

Catch-basins were built on each side of the roadway about 300 feet apart, with outlets on the side hill below the driveway. Tile drains were laid on each side of the driveway, for draining the subsoil; the one on the up-hill side was on the outer line of the sidewalk, while the drain on the down-hill side was on the line of the gutter; these drains were laid at a depth of 2 feet 6 inches below the surface, and they discharge into the catch-basins.

The gutters were then excavated 6 inches below the sub-grade of the roadway, and filled with screened gravel as a foundation for paving. The gutters are 3 feet wide, of cobblestones which were picked out of the excavation. A stone foundation 9 inches in thickness was laid on the roadway. After breaking down all unevennesses of these stones they were covered with 3 inches of crushed stone from 2½ to 1½ inches in diameter, well rolled, and this was then covered with screened gravel or stone dust thoroughly watered and rolled to a hard surface. The walks are separated from the gutters by a border of loam 2 feet wide and 1½ feet deep. The walks have a fall of ¼ inch to a foot, from the outer edge to the loam border. They are constructed of 6 inches of crushed stone, covered with stone dust well compacted by watering and rolling.

The driveway from South to Centre Street has needed but slight repairs during the year. Early in the spring a short length of gutter was relaid, it having settled out of shape, and in the fall the whole surface received a thin coating of stone screenings, which was thoroughly rolled.

The spring or reservoir at the foot of Bussey Hill, near the drive, from which the college obtained its water supply, had been partially drained by the building of the drive, so that in dry weather a sufficient supply of water could not be easily obtained. To remedy this, a well was dug to a depth of about 8 feet below the bottom of the spring, and curbed with a dry stone wall; it has given an ample supply of water.

#### FRANKLIN PARK.

Work was begun here early in April. The Playstead was first cleared of stone, the stone being broken up and deposited where it could be conveniently used on the driveway. A large area, about 9 acres, being too low to be drained, the soil was removed, and it was

then filled, the greatest depth of filling being 6 feet; the filling came from the excavations for the driveway and its adjoining slopes. After the filling was done the soil was restored; drains were laid for draining the Playstead; the field of 27 acres received a top dressing of stable manure and other fertilizers, and was then ploughed and tilled through the summer. In September grass-seed was sown, which, before cold weather set in, was well started.

The grading of the drives around the Playstead has been carried on through the season, and is substantially completed. About 8,200 square yards of roadway have been ballasted, of which about 6,000 square yards are covered with crushed stone, and only require covering with a coating of binding gravel or screenings from the crushed stones to be completed; 2,246 square yards of gutters have been paved with rectangular granite blocks; 6,740 square yards of walks have been covered with crushed stone, and 1,000 square yards entirely finished. Catch-basins and drains have been built for draining the whole of the drives around the Playstead, except for a short distance near the entrance to the Country Park. Usually 2-inch tile drains have been laid under the gutters on each side of the drive. Generally the method of construction of the driveways is the same as that described for the Arboretum, except that the roadway, gutters, grass border, and walks are wider at Franklin Park than at the Arboretum, and the gutters are paved with granite blocks instead of cobblestones.

The catch-basins both here and at the Arboretum are of the form shown in the accompanying sketch. The total length of vitrified pipe-drains laid is 4,397 feet, varying in diameter from 8 inches to 18 inches. The length of tile drain is 7,200 feet, 2 inches and 3 inches in diameter. The number of man-holes built is 5, and the number of catch-basins 25.

A stone-crushing plant was purchased, and this has crushed all the stone used for surfacing the drives and walks.

About 1,200 lineal feet of the circuit drive around The Country Park has been graded, and work on this drive is now in progress.

*The Overlook.* — The wall which supports the Overlook has been completed, with the exception of the coping. The walk which the wall supports has been graded, and covered with crushed stone. The site of the proposed building has been partially excavated, and a drain to connect the building with the sewer in Sigourney Street is being built.

*Administration Buildings.* — The dwelling-house at the corner of Williams and Walnut Streets has been occupied as an office for the police and engineering forces since the park was laid out. During the past season there have been built in the rear of it a carpenter shop, a blacksmith shop, and a yard and sheds for the storage of materials and tools.

The dwelling-house and stable have been painted, as have also the dwelling-house and stable occupied by the Assistant Landscape Gardener.

#### MARINE PARK.

At the beginning of the season changes were made in the building at the entrance to the pier to furnish larger accommodations for women and children, and also to provide a kitchen for the refectory.

A small amount of grading was done where the grading of Q Street had left some dangerous slopes on the park line.

Considerable filling has been dumped on the flats by parties who have been dredging in the vicinity. A portion of this filling has been of gravel, which will probably remain where deposited; but the balance, being clay, may be washed away by the action of the waves.

*Wooden Pier.* — No repairs have been required on the wooden pier.

The number of lamps under the shelter at the outer end of the pier

was increased, and a style of lamp purchased which was better suited to the locality and conditions than those first used.

*Iron Pier.* — A contract was made on July 11 for the construction of a permanent iron pier, extending from the temporary wooden pier. The length of iron pier contracted for is 12 spans, or 741 feet, with the option on the part of the Commissioners of requiring an additional 5 spans, or 308 lineal feet, to be built. The contractors began work on the ground September 9, and at present have sunk the foundation columns for 6 spans, and the columns are partially filled with concrete.

A large amount of iron-work for the superstructure is on the ground, and everything is in good shape for going on with the work as soon as the weather is suitable for placing the concrete.

#### WOOD ISLAND PARK.

Upon Arbor day about one hundred trees were planted upon Neptune Road, the soil for the same having been deposited in 1885.

On the 27th of April a contract was made for building the abutments for a bridge over the Boston, Revere Beach, & Lynn R.R. Work was begun on May 9, and completed December 9.

#### CHARLES-RIVER EMBANKMENT.

A force was set to work here on August 26, grading the grounds. Nearly sufficient material was on the ground for the purpose, the Embankment having been, for the past two years, a free dumping-ground for clean earth, or other material suitable for filling. A large amount of ashes has been deposited on the grounds by the Health Department. The whole of the Embankment has been graded to a sub-grade, with the exception of the portions occupied by the Paving Department and the Commissioners of West Boston Bridge. The force is now engaged covering portions of the grounds where ashes were used for sub-grading with a layer of clay.

The gymnastic ground at the northerly end of the Embankment has been covered one foot in depth with gravel dredged from Charles River. A contract was made October 31 for covering the areas to be planted with loam. This work is now in progress, and it is expected to have it completed in season for planting in the spring.

#### COVERED CHANNEL OF MUDDY RIVER.

This conduit, damaged as described in the report of the City Engineer for 1884, was repaired in 1885, but a length of about 650 feet received but slight repairs at that time, it being thought that the settlement and consequent distortion had ceased. It, however, continued to grow worse, and about a year ago it became necessary to support it by interior bracing. This bracing still remains in the conduit, but it is an obstruction to the flow of water, and is liable to cause serious trouble. This section will have to be practically rebuilt. Frequent examinations of the whole conduit have been made, and no deterioration has been discovered in any other part of it.

#### IN GENERAL.

A large amount of work, not described in the foregoing account, has been done, such as the making of surveys, plans and estimates for work to be done in the future.

During the past year an unusually large amount of work similar in character to that on the parks has been in progress in this vicinity;

consequently there has been great difficulty in securing competent workmen, even at the advanced wages which it has been necessary to pay. Contractors have been unable to obtain materials promptly, and this, with the high price of labor and materials, has caused frequent delays and unusually high prices.

In consequence of these conditions, which could not have been foreseen when the estimates were made, the cost of the work done this season has been in excess of that estimated, and the delays consequent upon the difficulty of obtaining labor have retarded the work so that the volume of work done during the season was less than was expected.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in the Appendix. The openings have all been remeasured for this report.

WILLIAM JACKSON,  
*City Engineer.*

## APPENDIX A.

*Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1888.*

NAME OF BRIDGE.	LOCATION.	NUMBER OF OPENINGS.	WIDTH.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown .	1	35	3
" "	Over Miller's River .	1	35	7
Broadway .	Over Fort-Point Channel .	1	43	3
Cambridge-st. .	Ward 25 to Cambridge .	1	30	5
Canal .	Boston to East Cambridge .	1	35	10
Charles-river .	Boston to Charlestown .	1	36	0
Chelsea (South Channel) .	Charlestown to Chelsea .	1	38	8
" (North " ) .	" " .	1	44	6
Chelsea-st. (East Boston side) .	East Boston to Chelsea .	2	33	0
" (Chelsea side) .	" " .		34	3
Commercial-point .	Ward 24 .	1	24	0
Congress-st. (Boston side) .	Over Fort-Point Channel .	2	43	3
" (South Boston side) .	" " .		43	11
Dover-st. .	" " .	1	36	0
Eastern R.R. .	Boston to Charlestown .	1	35	10
" .	Over Miller's River .	1	35	7
Essex-st. .	Ward 25 to Cambridge .	1	30	11
Federal-st. .	Over Fort-Point Channel .	1	36	0

Fitchburg R.R.	.	.	.	.	.	1	36
" " (for teaming freights)	.	.	.	.	.	1	36
Grand Junction R.R.	.	.	.	.	.	1	32
" " "	.	.	.	.	.	1	34
Granite	.	.	.	.	.	1	30
Lowell R.R. (freight)	.	.	.	.	.	1	35
" " (passenger)	.	.	.	.	.	1	35
Malden	.	.	.	.	.	1	43
Meridian-st. (East Boston side)	.	.	.	.	.	2	59
" (Chelsea side)	.	.	.	.	.	59	0
Mt. Washington ave. (Boston side)	.	.	.	.	.	2	42
" " (So. Boston side)	.	.	.	.	.	2	42
Neponset	.	.	.	.	.	1	31
New York & New England R.R.: (Boston side)	.	.	.	.	.	2	40
" " " (So. Boston side)	.	.	.	.	.	2	40
" " "	.	.	.	.	.	1	28
North Beacon-st.	.	.	.	.	.	1	30
North Harvard st.	.	.	.	.	.	1	31
Old Colony R.R.	.	.	.	.	.	1	36
" "	.	.	.	.	.	1	35
Prison-point	.	.	.	.	.	1	35
Warren	.	.	.	.	.	1	36
West Boston (Boston side)	.	.	.	.	.	2	35
" (Cambridge side)	.	.	.	.	.	2	36
Western-ave.	.	.	.	.	.	1	31
" "	.	.	.	.	.	1	30
Boston to Charlestown	.	.	.	.	.	.	.
" " "	.	.	.	.	.	.	.
Ward 25 to Cambridge	.	.	.	.	.	.	.
East Boston to Chelsea	.	.	.	.	.	.	.
Ward 24 to Milton	.	.	.	.	.	.	.
Boston to East Cambridge	.	.	.	.	.	.	.
" " "	.	.	.	.	.	.	.
Charlestown to Everett	.	.	.	.	.	.	.
East Boston to Chelsea	.	.	.	.	.	.	.
" " "	.	.	.	.	.	.	.
Over Fort-Point Channel	.	.	.	.	.	.	.
" " "	.	.	.	.	.	.	.
Ward 24 to Quincy	.	.	.	.	.	.	.
Over Fort-Point Channel	.	.	.	.	.	.	.
" " "	.	.	.	.	.	.	.
Over South Bay	.	.	.	.	.	.	.
Ward 25 to Watertown	.	.	.	.	.	.	.
Ward 25 to Cambridge	.	.	.	.	.	.	.
Over Fort-Point Channel	.	.	.	.	.	.	.
Ward 24 to Quincy	.	.	.	.	.	.	.
Charlestown to Cambridge	.	.	.	.	.	.	.
Boston to Charlestown	.	.	.	.	.	.	.
Boston to Cambridge	.	.	.	.	.	.	.
" " "	.	.	.	.	.	.	.
Ward 25 to Cambridge	.	.	.	.	.	.	.
Ward 25 to Watertown	.	.	.	.	.	.	.



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Newton street . . . . .	4, 11
Norfolk street . . . . .	5
North Beacon street . . . . .	4, 13
North Harvard street . . . . .	4, 14
Park street . . . . .	5
Prison-point . . . . .	4, 14
Public Garden foot-bridge . . . . .	4, 11
Savin Hill avenue . . . . .	6
Second street . . . . .	5
Shawmut avenue . . . . .	4, 11
Silver street . . . . .	5
Sixth street . . . . .	5
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TWENTY-SECOND ANNUAL REPORT

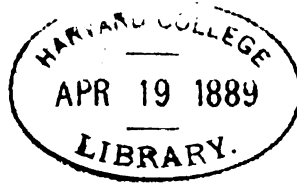
OF THE

CITY ENGINEER,

FOR THE YEAR 1888.



BOSTON:  
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1889.



41  
Hon. Jackson.  
City Engineer

# CITY OF BOSTON.



## TWENTY-SECOND ANNUAL REPORT

OF THE

# CITY ENGINEER,

*With Compendium.*

William Jackson,

*City Engineer.*

L.  
1889.

Ordinance  
report  
for the

ed under

A. — Those persons in the Department proper, which consist in examination and vision of structural repairs of bridges; in designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council. (City Engineer's Department.)

B. — Superintendence of the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works. (Water-Works.)

C. — Charge of the construction of a system of intercepting and outlet sewers. (Improved Sewerage, or Main Drainage.)

D. — Charge of the engineering work in connection with the Back-Bay and other proposed parks. (Parks.)





Wm. Jackson,  
City Engineer

CITY OF



BOSTON.

TWENTY-SECOND ANNUAL REPORT

OF THE

CITY ENGINEER,

FOR THE YEAR 1888.

OFFICE OF THE CITY ENGINEER, CITY HALL,

BOSTON, Jan. 14, 1889.

*To the Honorable City Council: —*

In compliance with the seventh section of the ordinance relating to the Engineer's Department, the following report of the expenses and operations of the department for the year 1888 is respectfully submitted: —

The duties of the City Engineer may be classified under the following heads: —

A. — Those pertaining to the City Engineer's Department proper, which consist in examination and supervision of structural repairs of bridges; in designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council. (City Engineer's Department.)

B. — Superintendence of the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works. (Water-Works.)

C. — Charge of the construction of a system of intercepting and outlet sewers. (Improved Sewerage, or Main Drainage.)

D. — Charge of the engineering work in connection with the Back-Bay and other proposed parks. (Parks.)

The expenses incurred under the head C are paid wholly from a special appropriation.

#### A. — CITY ENGINEER'S DEPARTMENT.

The following is a statement of engineering expenses from January 1, 1888, to January 1, 1889: —

Amount expended from department appropriation for 1887-88 . . . . .	\$9,472 47
Amount expended from department appropriation for 1888-89 . . . . .	23,686 57
Total . . . . .	<u>\$33,159 04</u>

Condition of department appropriation: —

Amount of appropriation for financial year 1888-89 . . . . .	\$34,000 00
Amount expended to January 1, 1889 . . . . .	23,686 57
Unexpended balance, January 1, 1889 . . . . .	<u>\$10,313 43</u>

#### CLASSIFICATION OF EXPENSES.

Salaries of City Engineer, assistants, draughtsmen, transitmen, levellers, rodmen, etc. . . . .	\$30,403 75
Engineering instruments and repairs of same . . . . .	110 54
Drawing-paper, and all materials for making plans . . . . .	334 04
Stationery, printing-stock, note-books, postage, etc. . . . .	309 86
Reference library, binding books, and photographs of work . . . . .	441 89
Printing . . . . .	87 74
Travelling expenses (including horse-keeping, repairs on vehicle, etc.) . . . . .	511 73
Telephone service . . . . .	125 75
Furniture cases for plans and books, etc. . . . .	185 50
Blue-process printing . . . . .	130 33
Incidental expenses, and all other small supplies . . . . .	180 41
New buggy and harness . . . . .	337 50
Total . . . . .	<u>\$33,159 04</u>

The number of persons employed and paid from the department appropriation was, on the 1st of January, 1888

(including the City Engineer), 20. The present number is 21. The operations of the department for the year, together with such general information relating to the various works and structures, finished and in progress, as is thought to be of interest, are given in the following statements: —

### BRIDGES.

In accordance with Section 5, Chapter 18, of the Revised Ordinances, the estimates of cost of repairs submitted by the Superintendent of Bridges has been revised and reported upon, and structural repairs required have been ordered and supervised.

As required by Section 4 of the above, examinations have been made of all highway bridges within the city limits, and the usual routine work of superintending the repairs made by the Bridge Department upon those in its charge has been done.

In addition to the regular annual report, a special report on the condition of the city bridges was made in obedience to an order of the City Council. (See City Doc. No. 117, 1888.)

#### LIST OF BRIDGES INSPECTED.

Three bridges have been added to the list this year, — Boylston street, over Boston & Albany Railroad; Agassiz-road Bridge, in Back Bay Fens; and Neptune-road Bridge, in East Boston.

In the list, those marked with an asterisk are over navigable water and are each provided with a draw.

#### I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Agassiz road, in Back Bay Fens.

Ashland street, Ward 23, over Boston & Providence Railroad.

Athens street, over New York & New England Railroad.

Beacon Entrance, Back Bay Fens, over Boston & Albany Railroad.

Beacon street, over outlet to Back Bay Fens.

Beacon street, over Boston & Albany Railroad.

Berkeley street, over Boston & Albany Railroad.

Berkeley street, over Boston & Providence Railroad.

Blakemore street, over Boston & Providence Railroad, Ward 23.

Boylston street, in Back Bay Fens.

Boylston street, over Boston & Albany Railroad.

\* Broadway, over Fort Point Channel.

Broadway, over Boston & Albany Railroad.

Brookline avenue, over Boston & Albany Railroad.

- \*Charles river, from Boston to Charlestown.
- \*Chelsea (south), over South Channel, Mystic river.
- \*Chelsea street, from East Boston to Chelsea.
- Columbus avenue, over Boston & Albany Railroad.
- \*Commercial point, or Tenean, Ward 24.
- Commonwealth avenue, in Back Bay Fens.
- \*Congress street, over Fort Point Channel.
- Dartmouth street, over Boston & Albany and Boston & Providence Railroads.
- \*Dover street, over Fort Point Channel.
- \*Federal street, over Fort Point Channel.
- Ferdinand street, over Boston & Albany Railroad.
- Franklin-street foot-bridge, over Boston & Albany Railroad.
- Huntington avenue, over Boston & Albany Railroad.
- Linden Park street, over Stony brook.
- \*Malden, from Charlestown to Everett.
- \*Meridian street, from East Boston to Chelsea.
- \*Mt. Washington avenue, over Fort Point Channel.
- Neptune road, over Boston, Revere Beach, & Lynn Railroad.
- Newton street, over Boston & Providence Railroad.
- Public Garden foot-bridge.
- Shawmut avenue, over Boston & Albany Railroad.
- Swett street, east of New York & New England Railroad.
- Swett street, west of New York & New England Railroad.
- \*Warren, from Boston to Charlestown.
- West Chester park, over Boston & Albany Railroad.
- West Chester park, over Boston & Providence Railroad.
- West Rutland square foot-bridge, over Boston & Providence Railroad.
- Winthrop, from Breed's Island to Winthrop.

## II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

- \*Cambridge street, from Brighton to Cambridge.
- Central avenue, from Ward 24 to Milton.
- \*Chelsea (north), from Charlestown to Chelsea.
- \*Essex street, from Ward 25 (Brookline) to Cambridge.
- \*Granite, from Dorchester, Ward 24, to Milton.
- Longwood avenue, from Ward 22 to Brookline.
- Mattapan, from Ward 24 to Milton.
- Milton, from Ward 24 to Milton.
- \*Neponset, from Ward 24 to Quincy.
- \*North Beacon street, from Brighton to Watertown.
- \*North Harvard street, from Brighton to Cambridge.

Spring street, from West Roxbury to Dedham.

\*Western avenue, from Brighton to Cambridge.

\*Western avenue, from Brighton to Watertown.

### III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

Albany street, over Boston & Albany Railroad.

\*Canal, from Boston to Cambridge.

Dorchester street, over Old Colony Railroad.

\*Prison Point, from Charlestown to Cambridge.

\*West Boston, from Boston to Cambridge.

### IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

#### *1st. — Boston & Albany Railroad.*

Commonwealth avenue, Brighton.

Harrison avenue.

Market street, Brighton.

Tremont street.

Washington street.

#### *2d. — Boston & Maine Railroad, Western Division.*

Mystic avenue.

Main street.

#### *3d. — Boston & Maine Railroad, Eastern Division.*

Mystic avenue.

Main street.

#### *4th. — Boston, Revere Beach, & Lynn Railroad.*

Everett street.

#### *5th. — New York & New England Railroad.*

Broadway.

Dorchester avenue.

Fifth street.

Forest Hills avenue, Ward 24.

Fourth street.

Harvard street, Ward 24.

Norfolk " " "

Norfolk " " "

Second street.

Silver street.

Sixth street.

Third street.

Washington street, Ward 24.

*6th. — Old Colony Railroad.*

Adams street.

Ashmont street and Dorchester avenue.

Cedar Grove Cemetery.

Commercial street.

Savin Hill avenue.

*7th. — Old Colony Railroad, Providence Division.*

Beech street, Ward 23.

Bellevue street, Ward 23.

Canterbury street, Ward 23.

Centre street, or Hog Bridge, Ward 23.

Centre and Mt. Vernon streets, Ward 23.

Dudley avenue, Ward 23.

Park street, Ward 23.

## RECAPITULATION.

I.	Number wholly supported by Boston . . . . .	42
II.	Number of which Boston supports the part within its limits . . . . .	14
III.	Number of which Boston pays a part of the cost of maintenance . . . . .	5
IV.	Number supported by railroad corporations : —	
1.	Boston & Albany . . . . .	5
2.	Boston & Maine, Western Division . . . . .	2
3.	“ “ Eastern Division . . . . .	2
4.	Boston, Revere Beach, & Lynn . . . . .	1
5.	New York & New England . . . . .	13
6.	Old Colony . . . . .	5
7.	“ “ Providence Division . . . . .	7
	Total number . . . . .	96

## I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

## AGASSIZ-ROAD BRIDGE (IN BACK BAY FENS).

This is a new bridge, built in 1887, of brick and stone masonry, and was opened to the public on Oct. 2, 1888. It is maintained by the Park Department, and is in good condition.

## ASHLAND-STREET BRIDGE (OVER BOSTON &amp; PROVIDENCE RAILROAD, WARD 23).

The present structure is of iron, and was built in 1875.

No work has been done on this bridge, and it is in good condition.

**ATHENS-STREET BRIDGE (OVER NEW YORK & NEW  
ENGLAND RAILROAD).**

This is an iron bridge, and was built in 1874.

It needs painting; otherwise it is in good condition.

**BEACON-ENTRANCE BRIDGE (IN BACK BAY FENS, OVER  
BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1881-82.

It is maintained by the Park Department, and is in good condition.

**BEACON-STREET BRIDGE (OVER OUTLET OF BACK BAY).**

This is an iron bridge, and was built in 1880-81.

It has been sheathed, and is in good condition.

**BEACON-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge; it was built in 1881-82, and was widened in 1887-88.

The work of widening this bridge was finished during the year, and it is in good condition, except that it needs painting.

**BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge. It was built by the Boston Water Power Company, and was accepted by the city in 1869.

No changes have been made on this bridge, and it remains in the condition heretofore reported. It is not strong enough for the position it occupies. It is on a wide street, much used for public processions. Both bridge and abutments should be rebuilt. The sidewalks and some of the floor timbers must be renewed.

**BERKELEY-STREET BRIDGE (OVER BOSTON & PROVIDENCE  
RAILROAD).**

This is an iron bridge. It was built by the Boston Water Power Company, and was accepted by the city in 1869.

The concrete sidewalks have been put in order during the year, and the bridge has been painted. It is in fair condition.



**BLAKEMORE-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge. It was built in 1881-82.

The bridge needs painting; otherwise it is in good condition.

**BOYLSTON-STREET BRIDGE (IN BACK BAY FENS).**

This is a stone masonry bridge, and it was built in 1881-83.

It is maintained by the Park Department, and is in good condition.

**BOYLSTON-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and it was built in 1886-88.

This is a new bridge just opened to travel. For description of iron-work see page 19. The abutments were described and illustrated in last year's report.

**\* BROADWAY BRIDGE (OVER FORT-POINT CHANNEL).**

This is an iron bridge. It was built in 1869-71, and the draw and its foundation were rebuilt in 1874-75.

The wood-work of the bridge below low-water mark has been examined by a diver; the front of the draw pier was found to be so weakened from the attacks of the limnoria that it will be necessary to rebuild it in a few years. The remaining wood-work under water is in better condition, and will last some years longer.

The spans over Foundry and Lehigh streets and the two 100-foot spans are of light construction, and will soon have to be replaced by stronger structures. The steep grades at each end of the bridge save it from much heavy teaming.

Three varieties of asphaltic roadway pavement have been laid on this bridge at the expense of the new Harvard Bridge, for experimental purposes; an area of about  $12 \times 50$  feet of each kind having been laid. Repairs are necessary to the sidewalks, and one of the 100-foot spans requires a new under-floor.

**BROADWAY BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, was built in 1880-81, and is in good condition.

**BROOKLINE-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, and was built in 1884. It has been painted, and is in good condition.

**\*CHARLES-RIVER BRIDGE (FROM BOSTON TO CHARLESTOWN.)**

This is a wooden pile bridge with an iron draw. The original bridge was built in 1785-86, the present structure was built in 1854-55, and the draw was built in 1870. It is an old bridge, and is only in passable condition.

The draw foundation has been repaired, and is now in fair condition.

The piling has been carefully examined below low-water mark by a diver, and a few piles were found to have been slightly damaged by the limnoria, — not more than six or eight being discovered out of about 700 examined, and in no case was serious weakness found. The piles above low tide are worn, and many of them are in poor condition. The roadway floor and the paving are also in poor condition. It will be necessary to rebuild this bridge at an early day.

Repairs are necessary to the under-floor. New trucks are required, the draw should be repaired, and the roadway needs repaving.

**\*CHELSEA BRIDGE, SOUTH (OVER SOUTH CHANNEL, MYSTIC RIVER).**

This a pile bridge with an iron draw. The original bridge was built in 1802-3, and the present structure in 1876-77. Only the usual repairs have been made, and the bridge is in fair condition.

Repairs are required on the timber-work and on the track.

**\*CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

This wooden pile bridge was originally built in 1834, and was rebuilt in 1848; the present structure was built in 1873, and the draw was built in 1868.

The draw and draw foundations are in bad condition, being old and decayed, and the piling of the foundation has been seriously injured by the limnoria. The draw should be rebuilt and widened during the coming year, it now being only 22 feet in width.

The fixed part of the bridge is in fair condition. It will be necessary to rebuild the bridge above the piles to a higher grade when a new draw is built.

It is necessary to repair the draw this year.

**COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, was originally built in 1865, and the present structure was built in 1876-77.

The wire guys attached to the main trusses, mentioned in last year's report, have not been removed. The bridge has been painted, and is in fair condition.

**\*COMMERCIAL-POINT OR TENEAN BRIDGE (WARD 24).**

This is a wooden pile bridge with a wooden leaf draw. It was originally built in 1833, and the present structure was built in 1875.

Both the upper and under roadway planking has been renewed and a few stringers added. The bridge is in fair condition.

**COMMONWEALTH-AVENUE BRIDGE (IN BACK BAY FENS).**

This is an iron bridge, and it was built in 1881-82. It is in good condition.

**\*CONGRESS-STREET BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge with an iron turn-table draw on a stone masonry foundation. It was built in 1874-75.

The piling was examined by a diver and found to be only slightly damaged by worms. Some of the piles have been renewed on account of decay above the water-line, and some others should be renewed.

The floor of the bridge is in poor condition; it has been patched, and about one-half of it must be renewed.

The vacant spaces under the bridge adjoining the old Russia wharf, mentioned in last year's report, have been filled and the paving relaid.

**DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND BOSTON & PROVIDENCE RAILROADS).**

This is an iron bridge; it was originally built in 1869, and the present structure was built in 1878-79.

The under-floor is poor; otherwise the bridge is in good condition.

**\*DOVER-STREET BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge, with an iron draw; it was originally built in 1805, was rebuilt in 1858-59, and the present structure was built in 1876. The work of widening the water-way to the legal limit of 36 feet is nearly completed. The under-floor of the bridge requires patching; otherwise the bridge, as a whole, is in fair condition.

**\*FEDERAL-STREET BRIDGE (OVER FORT-POINT CHANNEL).**

This bridge was built in 1827-28, was rebuilt in 1857-58, and the present structure was built in 1872-73.

It is a wooden pile bridge with a double wooden draw. It is in bad condition, and should be rebuilt at once. (See special report to Mayor, Oct. 8, 1888. Appendix B, Doc. 117, 1888.)

Repairs must be made to the trucks, draw, under-floor, fences, and paving, at an estimated cost of \$5,000, if the bridge is not rebuilt.

**FERDINAND-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1864-65, and was strengthened in 1877.

The recommendation made last year is renewed; that is, that the part supported on posts be filled solid, and that the bridge be rebuilt.

**FRANKLIN-STREET FOOT-BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1883, and is in good condition.

**HUNTINGTON-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1872, and the abutments were rebuilt in 1876-77.

It is in good condition.

**LINDEN PARK-STREET BRIDGE (OVER STONY BROOK).**

This is a wooden truss bridge. It was built in 1886, and is in fair condition.

**\*MALDEN BRIDGE (FROM CHARLESTOWN TO EVERETT).**

The original bridge was built in 1787. The present structure was built in 1875, and the draw was built in 1872.

It is a pile bridge with a wooden turn-table draw on a pile foundation. The fixed part of the bridge is in good condi-

tion ; the draw is old, narrow, in poor condition, and can be kept in a safe condition but a short time longer.

The piling has been examined by a diver and found to be in good condition.

**\*MERIDIAN-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

This is a wooden pile bridge with a wooden turn-table draw on a pile foundation. The original structure was built in 1856. It was rebuilt soon afterwards ; it was widened and rebuilt as at present in 1884, excepting the draw, which was built in 1875-76.

The draw needs repairs, which have been ordered and partly made ; it shows signs of age, but will serve for some years to come. The piles have been examined by a diver and found in good condition. The fixed part of the bridge is in good condition.

**\*MT. WASHINGTON-AVENUE BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge with an iron draw. It was built in 1854, and was rebuilt in 1870-71.

The usual necessary repairs have been made, and the bridge is in fair condition.

**NEPTUNE-ROAD BRIDGE (OVER REVERE BEACH & LYNN RAILROAD IN EAST BOSTON).**

This is an iron bridge, and it was built in 1887-88.

It is maintained by the Park Department, and is in good condition.

**NEWTON-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge, and was built in 1872.

It has been painted, and is in good condition.

**PUBLIC GARDEN FOOT-BRIDGE.**

This is an iron bridge. It was built in 1867, and was thoroughly repaired in 1887.

It is in good condition.

**SHAWMUT-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and it was built in 1871.

It needs painting, and the iron-work should be stripped for this purpose and also to allow of a careful examination. Only the usual repairs have been made.

**SWETT-STREET BRIDGES (OVER SOUTH BAY SLUICES).**

These are wooden bridges, and were built in 1875.

The easterly bridge has been replanked, both upper and under courses, and the sidewalks and fences renewed. The pile bulkheads have not been repaired, and are in bad condition. The westerly bridge is in poor condition.

**\*WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).**

This is a wooden pile bridge with an iron draw; it was originally built in 1828, and the present structure was built in 1883-84. The usual minor repairs have been made, and the bridge has been painted. It is in fair condition. A count of teams and foot passengers, on Dec. 20, 1888, showed the following results:—

Hourly record of pedestrians, teams, and horse cars, passing over each draw from 6 A.M. to 7 P.M., Thursday, Dec. 20, 1888. Omnibuses average 23 per hour. Weather, cold and windy; cloudy and snow squalls in A.M.; pleasant in P.M.; ground free from snow.

Time.	Pedestrians.	Teams.				Horse Cars.	Miscellaneous.
		One-horse.	Two-horse.	Three-horse.	Four-horse.		
6 to 7 A.M. . . .	909	84	44	0	1	53	
7 to 8 " . . .	1,356	348	129	0	0	87	
8 to 9 " . . .	829	333	106	1	4	95	
9 to 10 " . . .	561	343	145	4	4	90	1 six-horse team.
10 to 11 " . . .	578	381	144	3	4	93	1 " "
11 to 12 " . . .	529	347	129	4	4	90	
12 to 1 P.M. . . .	785	326	117	2	1	94	
1 to 2 " . . .	751	274	181	5	7	99	
2 to 3 " . . .	606	388	102	6	7	97	
3 to 4 " . . .	712	394	128	1	5	106	
4 to 5 " . . .	922	419	116	6	3	103	32 horses, without vehicles; 1 bicycle.
5 to 6 " . . .	1,235	501	163	3	6	114	
6 to 7 " . . .	1,762	139	46	0	0	103	
Total . . . . .	11,535	4,277	1,490	35	46	1,224	

Number of foot passengers on westerly sidewalk, 8,552.  
Number of foot passengers on easterly sidewalk, 2,983.

**WEST CHESTER PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1876.

The wood-work and sidewalks are in poor condition. The recommendation of previous years is renewed, that the bridge be made to conform to a better street profile.

**WEST CHESTER PARK BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge, and it was built in 1876.

It has been painted, and is in good condition.

**WEST RUTLAND SQUARE FOOT-BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge; it was built in 1882, and is in good condition.

**WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP).**

This is a pile bridge without a draw; it was originally built in 1839, was rebuilt in 1851, and was extensively repaired in 1870.

The piles have been reduced in size by the limnoria, and the superstructure is weakened by age. The bridge will need rebuilding in a few years, and when rebuilt, a considerable part of its length can probably be filled solid.

**II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.**

**\*CAMBRIDGE-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This is a wooden pile bridge with a wooden leaf draw. It was rebuilt in 1884, and is in good condition. The Legislature has ordered the water-way to be widened: (See report to Mayor, Sept. 25, 1888. Appendix A, Doc. 117, 1888.)

**CENTRAL-AVENUE BRIDGE (OVER NEPONSET RIVER, DORCHESTER LOWER MILLS).**

This is an iron bridge, and was built in 1876.

Part of the roadway has been sheathed, and the bridge is in fair condition.

**\*CHELSEA BRIDGE NORTH (FROM MYSTIC-RIVER CORPORATION WHARF TO CHELSEA).**

The original structure was built in 1802-3; the present structure was built in 1880, except the draw, which was built in 1873.

This is a wooden pile bridge with a wooden draw on a pile foundation. The piles under the draw have been examined by a diver and found in good condition.

The draw was built before the structure came into the charge of the city, and shows evidence of age. It is in safe condition for the present, but will last only a few years more. It will require repairs during the coming year. The fixed part of the bridge is in fair condition.

**\*ESSEX-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This is a wooden pile bridge with a wooden leaf draw, and was originally built in 1850. It was repaired last year, and is in fair condition. The Legislature has ordered the water-ways of the draw made 36 feet wide in the clear. The City of Boston maintains one-half of the draw. (See report to the Mayor, Sept. 25, 1888. Appendix A, Doc. 117, 1888.)

**\*GRANITE BRIDGE (FROM WARD 24 TO MILTON).**

This bridge was originally built in 1837. It is a wooden pile bridge with a wooden leaf draw. The water-way of the draw is ordered widened to 36 feet by the Legislature. The bridge is in fair condition. (See special report to Mayor, Sept. 25, 1888. Appendix A, Doc. 117, 1888.)

**LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOKLINE).**

The present structure was built in 1877. This is a wooden bridge, on wooden posts set in the ground. It is a poor bridge, and is only in passable condition. The construction of the Riverdale park will doubtless lead to the building of a new bridge of an entirely different character.

**MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).**

This is an iron bridge. The bridge, abutments, and centre pier are all in poor condition, and it should be rebuilt. The bridge has been put in safe condition for travel.



**MILTON BRIDGE (FROM WARD 24 TO MILTON).**

The original structure is very old; it was widened in 1871-72. The older part of this bridge was built of stone, and the widening is an iron structure on stone columns. The sidewalk has been rebuilt. The bridge should be examined and repaired during the low stage of water next summer. No change has been observed in the old stone-work.

**\*NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).**

The original structure was built in 1802, and the present structure was built in 1877. This bridge is a wooden pile bridge with an iron leaf draw; both leaves of the draw are maintained by Boston. It is one of the draws to be rebuilt by order of the Legislature. The bridge is in fair condition. (See report to Mayor, Sept. 25, 1888, Appendix A, Doc. 117, 1888.)

**\*NORTH BEACON-STREET BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge with a wooden leaf draw. The original structure was built in 1822, and the present structure in 1884.

It is in good condition.

**\*NORTH HARVARD-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This bridge was originally built in 1662, and was rebuilt in 1879.

It is a wooden pile bridge with a wooden leaf draw, and is ordered widened by the Legislature. The abutment is poor; otherwise the bridge is in good condition. (See report to Mayor, Sept. 25, 1888. Appendix A, Doc. 117, 1888.)

**SPRING-STREET BRIDGE (FROM WARD 23 TO DEDHAM).**

This is a stone bridge, and it is in good condition.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The original structure was built in 1824; the present structure was built in 1879-80.

It is a wooden pile bridge with a wooden leaf draw, and is ordered widened by the Legislature.

It is in fair condition.

(See report to Mayor, Sept. 25, 1888. Appendix A, Doc. 117, 1888.)

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge. It was built in 1824, the present draw was built in 1883, and the abutment was rebuilt in 1886. It is in good condition.

**III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.**

**ALBANY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

The original structure was built in 1856-57; was rebuilt in 1867-68, and again in 1886-87.

It is an iron bridge, and is in good condition.

**\*CANAL BRIDGE (FROM BOSTON TO CAMBRIDGE).**

**\*PRISON-POINT BRIDGE (FROM CHARLESTOWN TO CAMBRIDGE).**

**\*WEST BOSTON BRIDGE (FROM BOSTON TO CAMBRIDGE).**

These bridges are in the care of two commissioners, appointed, one from Boston and one from Cambridge, and the expense of maintenance is borne equally by each city. The Boston commissioner makes an annual report in print.

Canal bridge is a wooden pile bridge with a wooden turntable draw. The bridge was originally built in 1808; was rebuilt in 1852, and again rebuilt and widened in 1874; some of the piles in this bridge date from 1808. The piles have been examined by the diver and found to be in good condition below low water; above that point they are in only passable condition, and not much dependence is to be placed upon the oldest piles. The draw is in fair condition; the paving and part of the floor is in poor condition.

Prison-point bridge was originally built in 1833, and the present structure was built in 1876-77. It is a wooden pile bridge with an iron leaf draw. The structure is in good condition.

West Boston bridge was built in 1792-93, was rebuilt in

1854, and repaired in 1871; the draw was rebuilt in 1875, and the down-stream sidewalk on the Cambridge side of the draw was rebuilt in 1886.

It is a wooden pile bridge with a wooden turn-table draw. It is old, narrow, and some parts of it are in bad condition; portions of it have been repaired, and the other portions are in need of repairs, which it is expected will be made this year.

**DORCHESTER-STREET BRIDGE (OVER OLD COLONY RAILROAD).**

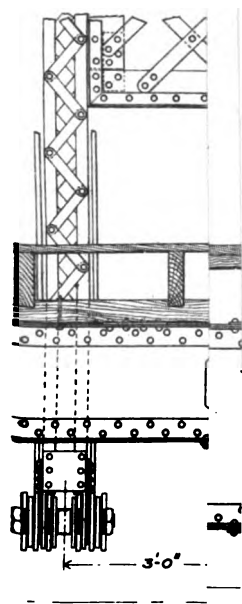
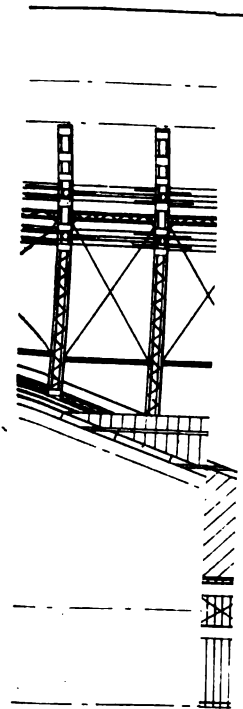
This is an iron bridge; it was built in 1869.

It is not in first-class condition, having suffered to a considerable extent from corrosion. It has been sheathed. The wood-work should be removed, and the iron-work examined, cleaned, and painted.

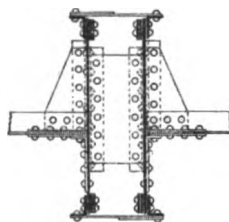
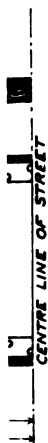
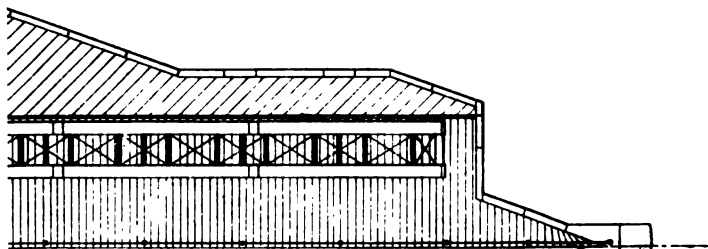
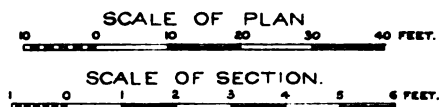
**IV. — BRIDGES SUPPORTED BY RAILROADS.**

Centre and Mt. Vernon-street bridge, over the Dedham branch, Providence division, Old Colony Railroad, is in process of rebuilding, and plans have been submitted for approval for rebuilding Tremont-street bridge over the Boston & Albany Railroad; Washington-street bridge, over the same road, is in poor condition.

The other bridges given in the list of those supported by railroad corporations require no special mention.



CITY OF BOSTON.  
 BOYLSTON STREET BRIDGE  
 OVER  
 BOSTON & ALBANY RAILROAD.  
 JANUARY 1889.



SECTION.

MISCELLANEOUS WORK AND CONSTRUCTION  
IN 1888.BOYLSTON-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).

The superstructure of this bridge, with the exception of an iron railing for it and its approaches, was completed in September last.

The angle at which Boylston street crosses the Boston & Albany Railroad is such that while the railroad location is but 60 feet wide, the distance across this location, measured on the centre line of the street, is 176.34 feet.

As no part of the railroad location was available for piers, nor for erecting falsework, it was necessary to make the bridge in one span, and provide for its erection by other than the usual methods.

A general plan of the bridge and a section of the floor is shown on the accompanying plate.

The width of the street is 80 feet, and this width on the bridge is divided by two trusses into one roadway and two overhanging sidewalks. The trusses are placed 54 feet 1 inch apart on centres, are alike in design and detail, and are each made of a pair of trusses so connected together as to form a complete truss, requiring no overhead bracing for its lateral support.

The length of main truss is 216 feet between centres of end piers, this length being divided into sixteen panels of 13 feet 6 inches each. Depth of truss between upper and lower chord pins varies from 9 feet 4 inches at ends, to 24 feet at middle. The pair of trusses composing each main truss are placed 6 feet apart on centres.

The following parts of the trusses were made of steel: upper chords, end-posts, all eye-bars 4 inches wide and over, chord-pins, and rollers. All other parts of the trusses, and the entire floor and lateral systems, are made of iron.

Floor-beams are double-plate girders, latticed and tied together on top and bottom flanges. The connection of floor-beams to trusses are so designed as to distribute the loads from beams equally to both halves of the main trusses, and are made by pins passing through the beams and small girders connecting double posts of trusses.

Roadway and sidewalk stringers are hard pine; under course of roadway plank is 3-inch clear hard pine, planed on one side to an even thickness; upper course of roadway plank is 2-inch spruce; and sidewalk plank is 1½-inch clear hard

pine, 6 inches to 7 inches wide, planed on one side, and jointed. The steel used in the bridge was required to show a tensile strength of from 62,000 to 70,000 pounds per square inch, an elastic limit not less than 35,000 pounds per square inch, an elongation in 8 inches of not less than 22 per cent, and a reduction of area at point of fracture of not less than 45 per cent.

Each cast of steel made at the mills was tested, and tests were made of the finished steel made from each cast. Four eye-bars, selected at random from those made for the bridge, were tested to breaking, with the following results: —

SIZE OF BAR.	5 × 1.	6 × 1½.	6 × 1½.	4 × 1.
Length, back to back, of pin-holes . . .	13.89'	13.89'	13.89'	27.5'
Elastic limit, pounds per square inch . .	44,390	36,460	36,520	33,210
Tensile strength, pounds per square inch	65,110	61,870	68,770	62,420
Elongation, per cent. in 12 feet . . . . .	18.1	19.	14.9	
Elongation, per cent. in 26 feet . . . . .				13.
Reduction of area at fracture, per cent. .	46.	49.4	50.	55.

All iron used in the bridge was tested and inspected at mills.

The steel for the work was made by Carnegie, Phipps, & Co., Pittsburgh, Penn., and the inspection and testing of the iron and steel was done by the Pittsburgh Testing Laboratory.

The steel eye-bars were manufactured by the Edge Moor Iron Company, Wilmington, Del.

Several methods of putting the main trusses of the bridge in place, without the use of falseworks in the railroad location, were considered; but the railroad officials having consented to allow their tracks to be occupied by movable falseworks for a few hours on Sunday mornings, the contractor was enabled to carry out the plan devised and preferred by him.

Each truss was erected on a staging at the side of, and parallel to, the railroad, one end of the truss resting on an abutment, and the other end on a timber horse or tower. Between the truss-shoe and the top of the tower were placed iron rollers, working between bars of railroad iron, and underneath the tower were wooden rollers, resting on timber sills.

When the truss was connected, its abutment end was placed upon an hydraulic jack, and the tower end swung about



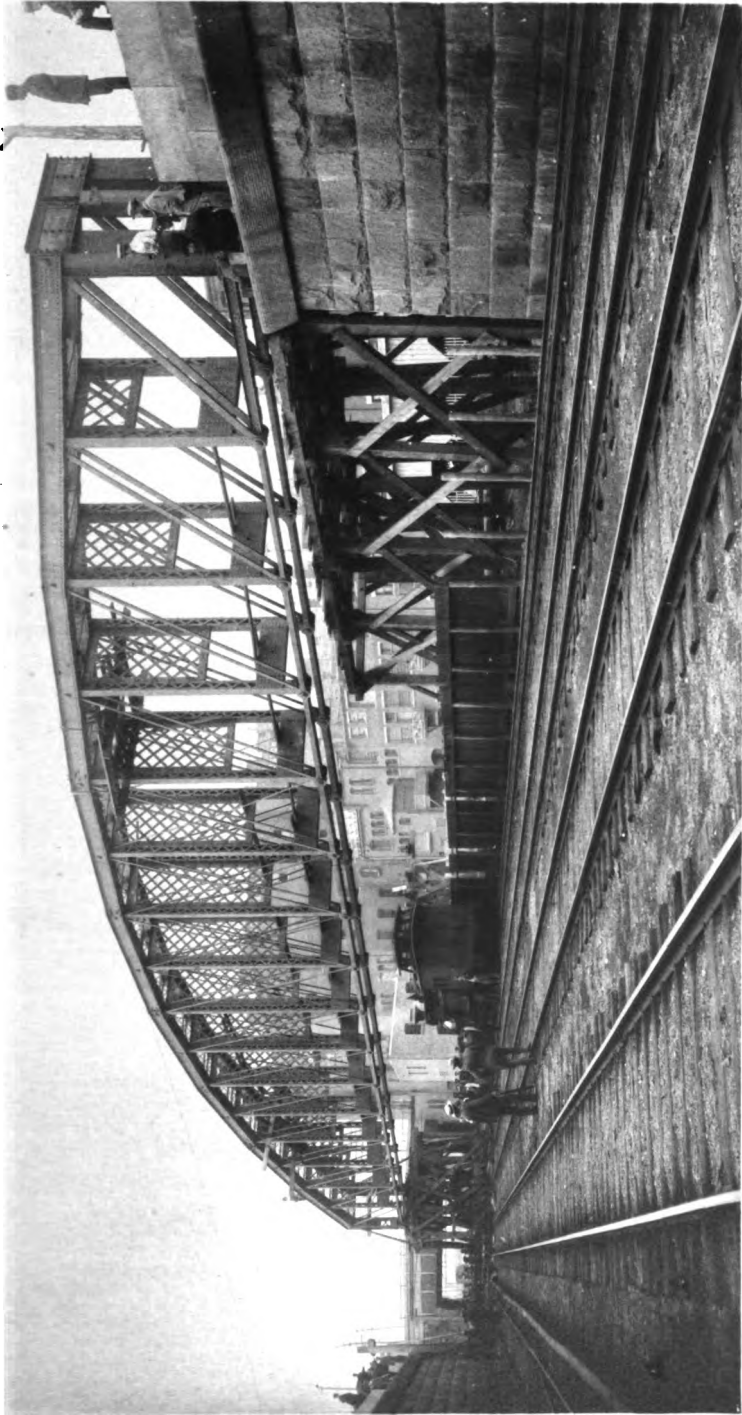
BOSTON, MASS.

BOYLSTON STREET BRIDGE  
216 FT. TRUSS ON STAGING.

HELIOTYPE PRINTING CO.







BOSTON, MASS.

BOYLSTON STREET BRIDGE.  
SWINGING 216 FT. TRUSS ACROSS TRACKS.

HEILTYPE PRINTING CO.



this jack as a pivot, to the opposite abutment, the tower moving; by means of the wooden rolls, on sills laid across the railroad tracks.

When the tower had reached the abutment, the top of the tower was adjusted to the proper level by means of jacks, and the end of the truss moved on the iron rolls and railroad iron from the tower to its proper place on the abutment.

The trusses were swung into place on the mornings of July 22 and 29, respectively, about four hours being taken each morning for doing the work, including time spent in waiting for the arrival and passage of trains on the tracks crossed.

The accompanying photographic views will serve to illustrate the previously described method of placing the trusses.

The design and detail plans for the bridge were prepared in this department, and the work of building and erecting the bridge was done by the Boston Bridge Works, the price paid under the contract being \$46,490.90.

#### BOYLSTON-STREET BULKHEAD.

Plans and specifications were prepared for building a wooden bulkhead and sidewalk opposite the land of an abuttor, between the bridge over the railroad and West Chester Park. The work was done by contract at a total cost of \$2,197.42, and was completed in October.

#### CHARLES RIVER AND NEPONSET RIVER BRIDGES.

Estimates and reports have been made of the cost of compliance with the requirement of the Legislature for widening the water-ways of six (6) bridges, four on the Charles and two on the Neponset river.

Orders have been issued by the Secretary of War, under the provision of the last River and Harbor Bill, passed by Congress, requiring the rebuilding of the four highway and five railroad bridges nearest the mouth of the Charles river.

The water-ways of the only remaining railroad bridge and of the four next highway bridges have been ordered widened by the State Legislature, and it is understood that petitions will be presented to include the two remaining highway bridges below the head of navigation at Watertown.

Every bridge on the river, with the exception of the new Harvard Bridge (yet unfinished), requires extensive changes to fit it for purposes of navigation, as contemplated in the above-mentioned orders. During the last session of the Legislature, an order was introduced for an inquiry by the

Harbor Commissioners into the expediency of closing the river to vessels with masts. The order was favored by the city, passed in committee, but failed to pass the House. Eleven highway bridges would be affected by the order; of these, the city of Boston supports the two most important, and pays half the cost of maintaining the remainder.

The City Council has already voted to petition Congress with reference to the city bridges affected by the order of the Secretary of War; and in view of the facts above stated, it is suggested that the inquiry into the merits of the case and the collection of statistics should be made.

#### CRISPUS ATTUCKS MONUMENT.

On Oct. 1, 1888, a contract was made with Robert Krause, the designer of the monument, to furnish and erect its foundation and pedestal for the sum of \$300 for the foundation and \$1,650 for the pedestal. The whole work was done as agreed, so as not to delay the formal dedication of the monument.

#### D STREET, SOUTH BOSTON.

A special report was made to the City Council, Nov. 22, 1888, upon means for abating a nuisance caused by the low grade of this street where it passes under the Old Colony Railroad.

#### EAST BOSTON FERRIES.

The work of rebuilding the slips of the South Ferry, East Boston side, in progress at the date of the last annual report, was completed in February, and cost \$13,487.38.

#### FEDERAL-STREET BRIDGE.

A special report was made upon the dangerous condition of this bridge on Oct. 8, 1888, and an estimate presented for rebuilding it.

#### TESTS OF GASKILL PUMPING-ENGINES AT CHESTNUT HILL.

On August 9, 10, August 22, 23, and September 26, 27, tests were made to ascertain the duty of the new high-service pumping-engines at Chestnut Hill, and also to determine the efficiency of the boilers connected with them.

The engines are of the type known as the Gaskill Horizontal Pumping-Engine, and were built by the Holly Manufacturing Co. of Lockport, N.Y.

The general specifications under which bids were received

were prepared by the City Engineer, in June, 1886, and the following extracts from them will show the capacity and duty required of the engines, and the methods prescribed for ascertaining the same:—

The engines are each to have sufficient capacity to easily deliver into the Fisher-Hill reservoir, so called, eight million (8,000,000) U.S. gallons of water per twenty-four hours, the total lift being from 116 to 128 feet.

The loss of action in the pumps must not exceed 4 per cent.

The piston speeds per minute, for the above-named capacities, are not to exceed, for direct-acting engines, one hundred and ten (110) feet, and for beam and fly-wheel engines (vertical), two hundred (200) feet.

As the efficiency of the engines is required to be shown independently of that of the boilers, the calculation of the required duties of the engines will be based upon a unit of water evaporated into dry steam in the boilers, the equivalent of which shall be eleven hundred (1,100) pounds of water evaporated from and at 212 degrees Fahrenheit.

Each engine will be required to exhibit a duty of one hundred million (100,000,000) foot-pounds per before specified unit of water evaporated into dry steam in the boilers.

The duty trials, one for each engine, will be conducted in the following manner: steam will be raised in the boilers to the lowest pressure at which the engines will run at full speed for capacity, when the fires will be hauled, the furnaces and ash-pits cleaned, and fresh fires started with as little delay as possible. As soon as the fires are well ignited the engine will be started and run at full speed for capacity, with the working pressure of steam, for twenty-four hours. At the latter part of the trial the fires will be burned down until the steam-pressure in the boilers is the same as at the beginning of the trial, when the engine will be stopped. The amount of water in the boilers is to be the same at the end as at the commencement of the trial. During the trial the pressure and temperature of the steam, and the temperature and weight of water supplied to the boilers, will be carefully noted. Calorimeter tests will be made to determine the quality of the steam supplied to the engines, and steam containing not more than 3 per cent. of entrained water will be considered dry steam.

The duty of the engine will be computed as follows: the area of the plunger in feet will be multiplied by the pressure in pounds, due to the total lift in feet, which will be obtained from the average reading of a correct pressure-gauge, attached to the force-main, near its connection to the pump, to which will be added the pressure due to the difference of level between the zero of the gauge and the water in the pump-well; the product thus obtained will be further multiplied by the total number of feet travelled by the plungers on their discharging strokes. This product equals the total work in foot-pounds. The amount of water evaporated by the boilers during the trial will be reduced to an equivalent number of pounds of water evaporated from and at 212 degrees Fahrenheit. The total work in foot-pounds divided by this equivalent evaporation, and the quotient multiplied by 1,100, will be the duty of the engine in foot-pounds, per specified unit of water evaporated into steam. All steam used for feed-pumps, condensers, and other appliances will be taken from the boiler furnishing steam to the engine, and no allowances will be made for steam so used.

The efficiency of the boilers will be tested at the duty trials.

Capacity tests of the engines will be made either in conjunction with the duty trials or separately; the amount of water pumped to be determined by weir-measurement at the Fisher-Hill reservoir.

The duty trials will be conducted by the City Engineer, and the expense of them will be borne by the City.

The Contractor, or his representatives, may be present at the duty and capacity trials of the engines, and may have access to all instruments used and notes taken.

The water fed to the boilers included water from the force main and the condensed water from the cylinder jackets, and was weighed in a barrel placed upon a tested platform scale. After weighing, the water was run into a large tub, from which the feed-pumps were supplied. In the test of Engine No. 1, a Knowles feed-pump was used for pumping the feed-water, and in the test of Engine No. 2, a feed-pump on the engine was used. The measurement of the feed-water was checked by a Worthington meter placed in the boiler feed-pipe.

The approximate quantity of water returned from the cylinder jackets was obtained by metering the supply from the force main, and subtracting this amount from total amount of feed-water used.

The tests were made under the direction of the City Engineer, and care was taken to secure accuracy in all observations. The observers were divided into night and day parties, and the more important readings were taken independently by two persons. The tests were under the immediate supervision of Mr. John E. Cheney, Assistant City Engineer, and Mr. Dexter Brackett, Supt. Eastern Division Boston Water Works, the former taking charge of the night party, and the latter the day party. Asst. Engineer John A. Gould acted as principal assistant to the above mentioned.

Calorimeter tests of the steam were made during the first and second tests by Mr. George H. Barrus, M.E. On account of the dryness of the steam shown by these tests, and the large amount of steam used in making them, it was not considered advisable to continue these tests at the third trial.

The weir-measurements at Fisher-Hill reservoir were made under the direction of Mr. Desmond FitzGerald, Resident Engineer and Supt. Western Division Boston Water Works.

It will be noted that, in accordance with the specifications, the duty of the engines was to be computed upon a unit of steam used by them, instead of upon the usual unit of coal burnt under the boilers. The duty of the engines was therefore to be shown in terms of heat furnished to, and consumed by them. The unit of steam used was made large, and consequently no allowances were made for any steam not used

by the engine proper, nor for any heat returned from the engine to the boiler.

The duty required by the specifications can be expressed in general terms as, —

Duty per 1,100 lbs. water evaporated from and at  $212^{\circ}$

$$= \frac{\text{Work done in ft.-lbs.} \times 1,100.}{\text{Equivalent lbs. of water evaporated from and at } 212^{\circ}.$$

At the trial of Engine No. 2, made on September 26, 27, the work done was 8,754,116,000 ft.-lbs., and the weight of water fed to the boiler and evaporated into steam at 79.9 lbs. pressure, was 88,453 lbs. The equivalent evaporation from and at

$$212^{\circ} \text{ was } 88,453 \times \frac{1,000}{966} = 91,566.25 \text{ lbs.}$$

Then, —

Duty per 1,100 lbs. water evaporated from and at  $212^{\circ}$

$$= \frac{8,754,116,000 \times 1,100}{91,566.25} = 105,164,600 \text{ ft. lbs.}$$

The specified unit of water evaporated into steam equals 1,100 pounds of steam made from and at  $212^{\circ}$ , and this can be expressed by the 1,062,600 heat units contained therein. By adapting the formula to this expression of the specified unit, it becomes general in character and application, and appears in the following form: —

Duty per 1,100 pounds steam made from and at  $212^{\circ}$ .

$$= \frac{W \times 1,062,600}{U - u} \text{ in which}$$

$W$  = Work done by engine in ft.-lbs.

$U$  = Heat units in total steam used, in excess of heat units in equal weight of water at  $212^{\circ}$ .

$u$  = (1st) Heat units returned from engine to boiler, plus (2d) heat units in steam used for any purpose other than running the engine, in excess of heat units in equal weight of water at  $212^{\circ}$ .

The duty of engine No. 2, as per trial of September 26, 27, is shown by the formula as follows: —

Duty per 1,100 pounds steam made from and at  $212^{\circ}$

$$= \frac{8,754,116,000 \times 1,062,600}{88,453 \times 1,000} = 105,164,600 \text{ ft. lbs.,}$$

the same result as obtained by the specified formula.

In the above-mentioned trial the heat of the feed-water was increased  $38.9^{\circ}$  by the addition of the jacket-water, and the



amount of heat returned to boiler from engine therefore equals  $88,453 \times 38.9 = 3,440,821.7$  heat units. The net duty of engine per 1,100 pounds steam made from and at

$212^\circ$  then equals  $\frac{3,754,116,000 \times 1,062,600}{88,453,000 - 3,440,821.7} = 109,421,100 \text{ ft.-lbs.}$

In case calorimeter tests of the steam had been made, "u" would have been increased by the addition of the heat units contained in steam used for the tests, in excess of heat units in equal weight of water at  $212^\circ$ .

*Record of Duty Trials of Two Gaskill Horizontal Compound Pumping-Engines, at Chestnut-Hill Pumping-Station, Boston Water Works.*

		Engine No. 1.	Engine No. 2.
1	Date of trials .....	Aug. 9-10, 1888.	Sept. 26-27, 1888.
2	Time of beginning .....	10.22 A.M.	9.50 A.M.
3	Duration .....	23 h. 51 m.	24 h. 11 m.
4	Total revolutions .....	27,402.5	28,316
5	Revolutions per minute .....	19.15	19.51
6	Net area of pump plunger .....	3.3652 sq. ft.	3.3652 sq. ft.
7	Length of stroke per revolution (3 ft. $\times$ 4) .....	12 ft.	12 ft.
8	Grade of water in pump well .....	123.14 "	123.38 "
9	Pressure in force main reduced to grade in ft. by mercury gauge .....	245.59 "	246.14 "
10	Total lift in ft. ....	122.45 "	122.76 "
11	Total lift reduced to pounds ....	52,972. lbs.	53,165 lbs.
12	Total weight of water evaporated in boilers .....	86,788.5 "	88,453 "
13	Equivalent weight of water evaporated from and at $212^\circ$ .....	89,843 "	91,566.3 "
14	Steam pressure in boilers .....	79.5 "	79.9 "
15	Duty of engines as developed by trials:—		

$$= \frac{\text{Work done in-foot lbs.}}{\text{Equivalent water evaporated from } 212^\circ} \times 1,100$$

$$\text{No. 1} = \frac{27,402.5 \times 3.3652 \times 12 \times 52.972 \times 144}{86,788.5 \times \frac{10,000}{988}} \times 1,100 = 103,347,500.$$

$$\text{No. 2} = \frac{28,316 \times 3.3652 \times 12 \times 53.165 \times 144}{88,453 \times \frac{10,000}{988}} \times 1,100 = 105,164,600.$$

*Record of Duty Trials. — Concluded.*

		Engine No. 1.	Engine No. 2.
16	Mean vacuum in condenser .....	26.3 ins.	26.53 ins.
17	Mean atmospheric pressure by barometer.....	30.4 “	29.35 “
18	Mean temperature of air in engine-room .....	79° F.	70.3° F.
19	Mean temperature of external air . .	75.1° F.	60.8° F.
20	Total volume of water pumped by plunger displacement, gallons .....	8,275,555	8,551,482
21	Total volume of water pumped by weir-measurement, gallons.....	8,112,725	8,377,000
22	Average slip of pumps.....	2%	2%
23	Indicated horse-power as determined by two sets of cards for each trial..	210.7	214.4
24	Horse-power in water lifted, pump-measurement, no allowance for slip.	178.66	182.76
25	Work done by pumps in per. cent. of indicated horse-power.....	84.79%	85.24%
26	Temperature of feed-water from force main .....	72.5	61.2
27	Temperature of feed-water after receiving jacket-water.....	104.95	100.1
28	Per centage of feed-water from jackets	13.0%	15.9%
29	Amount of feed-water received from jackets .....	12,281 lbs.	14,004 lbs.

The boilers used in connection with the engines are of the horizontal, return-tubular type, with external furnaces. They are 78 inches in diameter, 17 feet 11½ inches long between tube sheets, and each boiler contains 151 tubes, 3 inches outside diameter.

Shells of boilers are  $\frac{7}{16}$ -inch thick steel, single-riveted in roundabout seams, and double-riveted in horizontal seams. Tube sheets are  $\frac{1}{2}$ -inch thick steel. All rivet-holes were punched  $\frac{1}{8}$ -inch small, and reamed to size required for  $\frac{7}{8}$ -inch diameter rivets.

A feed-water heater is located in the smoke-flue between the boilers. It is made of 80 brass tubes, each 2½ inches

diameter, and 15 feet long, supported in racks on a portable carriage.

Samples of each sheet of steel used in the boilers were tested for tensile strength, elastic limit, and elongation.

The steel was made by Carnegie, Phipps, & Co., of Pittsburgh, Pa., and was inspected and tested by G. W. G. Ferris, Jr., C.E. of the same city.

The boilers were built by George Miles of Boston, and the flue feed-heater was made by the Atlantic Works of East Boston.

The designs for the boilers and flue-heater were furnished by the City Engineer.

*Record of Tests of Two Boilers at Chestnut Hill Pumping-Station, Boston Water Works.*

		Boiler No. 2.	Boiler No. 1.
1	Date of trials .....	Aug. 9-10.	Sept. 26-27.
1a	Time of beginning of trial .....	10.08 A.M.	9.30 A.M.
2	Duration of trial .....	24 h. 5 m.	24 h. 36 m.
	<i>Dimensions and Proportions.</i>		
3	Grate surface .....	38.5 sq. ft.	49 sq. ft.
3a	Area of least draught ...	6 " "	6 " "
4	Water-heating surface .....	2,164 " "	2,164 " "
5	Superheating surface .....	7 " "	7 " "
5a	Heating surface in feed-water heater.	931 " "	931 " "
6	Ratio of water-heating surface to grate surface .....	56:1	44:1
	<i>Average Pressures.</i>		
7	Steam pressure in boiler by gauge....	79.5 lbs.	79.9 lbs.
8	Absolute steam pressure .....	94.2 lbs.	94.3 lbs.
9	Atmospheric pressure by barometer ..	30.04 ins.	29.85 ins.
	<i>Average Temperatures.</i>		
11	External air.....	73° F.	56° F.
13	*Steam .....	326.2° F.	*
14	Escaping gases before passing feed-water heater ....	358° F.	399.8° F.

\*Steam thermometer proved to be incorrect, and was broken while being tested for correction.

*Record of Tests of Two Boilers. — Continued.*

		Boiler No. 2.	Boiler No. 1.
14a	Escaping gases after passing feed-water heater .....	208.5° F.	256.5° F.
15	Feed-water before passing heater ...	104.95° F.	100.1° F.
15a	Feed-water after passing heater .....	153.65° F.	163.2° F.
15b	Cochituate water from force main ...	72.4° F.	61.2° F.
	<i>Fuel.</i>		
18	Coal consumed .....	9,446 lbs.	9,266 lbs.
19	Total refuse dry { No. 1, 486.5 lbs. No. 2, 900 lbs. }	9.5%	5.3%
20	Total combustible (weight of coal, item 18; less refuse, item 19)....	8,546 lbs.	8,779.5 lbs.
21	Coal consumed per hour .....	392.2 "	376.7 "
22	Combustible consumed per hour ....	354.9 "	356.9 "
	<i>Water.</i>		
26	Total weight of water pumped into boiler and apparently evaporated ..	86,788.3 "	88,453 "
26a	Check on above measurement by meter measurement . .....	84,848 "	87,606 "
26b	Per cent. less by meter .....	2.2	1.0 "
26c	Feed-water taken from force main by meter measurement .....	75,486 lbs.	74,881 "
28	Equivalent water evaporated into dry steam from and at 212° F.	99,459.6 lbs.	101,897.9 "
	{ Including feed-water heater ....		
	{ Excluding " " " ....	95,121.2 "	96,060 "
29	Equivalent total heat derived from fuel in British thermal units		
	{ Including feed-water heater .....	96,074,870	98,850,891
	{ Excluding " " " ....	91,856,948	92,769,506
30	Equivalent water evaporated into dry steam from and at 212° F. per hour		
	{ Including feed-water heater ....	4,130 lbs.	4,142 lbs.
	{ Excluding " " " ....	3,950 "	3,905 "

*Record of Tests of Two Boilers. — Continued.*

		Boiler No. 2.	Boiler No. 1.
	<i>Economic Evaporation.</i>		
31	Water actually evaporated per lb. of coal, from actual pressure and temperature .....	9.19 lbs.	9.55 lbs.
32	Equivalent water evaporated per lb. of coal from and at 212° F.		
	{ Including feed-water heater ....	10.53 "	11.00 "
	{ Excluding " " " ....	10.07 "	10.37 "
33	Equivalent water evaporated per lb. of combustible from and at 212° F.		
	{ Including feed-water heater ....	11.64 "	11.61 "
	{ Excluding " " " ....	11.18 "	10.94 "
	<i>Commercial Evaporation.</i>		
34	Equivalent water evaporated per lb. of coal, with one-sixth refuse at 70 lbs. gauge pressure, from temperature of 100° F., = item 33 multiplied by .7249 —		
	{ Including feed water heater.....	8.44 "	8.42 "
	{ Excluding " " " " .....	8.07 "	7.93 "
	<i>Rate of Combustion.</i>		
35	Coal actually burned per sq. ft. of grate surface per hour .....	10.19 "	7.69 "
36	{ Consumption of dry coal per hour.	Per sq. ft. of grate surface .....	11.07 "
37	{ Coal assumed with one-sixth refuse.	Per sq. ft. of water-heating surface.	.197 "
38	{	Per sq. ft. of least draught .....	71.01 "
			71.7 "
	<i>Rate of Evaporation.</i>		
39	Water evaporated from and at 212° F. per sq. ft. of water-heating surface per hour, excluding feed-water heater.....	1.83 "	1.80 "
40	{ Water evaporated per hour from temperature of 100° F. into steam of 70 lbs. gauge pressure, excluding feed-water heater.	Per sq. ft. of grate surface	89.3 "
41	{	Per sq. ft. of water-heating surface.	1.59 "
42	{	Per sq. ft. of least area for draught.....	573 "
			566.3 "





*Record of Tests of Two Boilers. — Concluded.*

		Boiler No. 2.	Boiler No. 1.
	<i>Commercial Horse-power.</i>		
43	On the basis of 30 lbs. of water per hour evaporated from temperature of 100° F. into steam of 70 lbs. gauge pressure (= 34½ lbs. from and at 212°)		
	{ Including feed-water heater . . . . .	119.7 h.p.	120.1 h.p.
	{ Excluding " " " . . . . .	114.5 "	113.2 "

NOTE. — During a trial on Aug. 22, 23, Boiler No. 1 evaporated 10 lbs. of water per pound of coal, or an equivalent evaporation of 11.57 lbs. from, and at 212°. The lower evaporation obtained in the trials recorded above are believed to be largely due to the inferior quality of coal used.

The logs of the tests are shown in the table.

BOSTON, Aug. 30, 1888.

MR. WILLIAM JACKSON, *City Engineer, Boston*: —

DEAR SIR, — I beg to report as follows concerning my calorimeter test of the quality of the steam used by the Holly pumping-engine at the Chestnut-Hill Station of the Boston Water Works, during the ~~day~~ trial of the same, made at your request on the 9th and 10th instant.

The calorimeter used for the test was one of my continuous superheating calorimeters, a description of which is given in the "Transactions of the American Society of Mechanical Engineers," Vol. VII., page 178, and Vol. VIII., page 235, and it was attached to the main 10-in. steam pipe at a point about midway between the boiler and the pumping-engine. The sample of steam tested was drawn through a ½-inch perforated pipe which extended in a horizontal direction into the inside of the main, and diametrically across it.

The tests were in two series, one being made in the early part of the trial and one in the last part.

The steam used by the calorimeter was condensed in a surface condenser, and its weight determined. The whole quantity during the trial amounted to 1,369.5 pounds.

The accompanying record presents the full set of observations, taken after the apparatus had become heated to its normal state, corrected for errors of the thermometers; and appended to the record are computations giving the percentage of moisture obtained from the average readings of the trial.



The result of the tests shows that the steam contained  $\frac{24}{100}$  of one per cent. of moisture.

Respectfully submitted,

GEO. H. BARRUS.

### CALORIMETER TEST.

#### *Chestnut-Hill Pumping-Station.*

TIME.	PRESSURE.	TEMPERATURE OF STEAM SUPPLIED BY SUPERHEATER.		Temperature of sample. Steam when discharged.	WEIGHT OF STEAM CONDENSED DURING PRECEDING HALF-HOUR.	
		Entering jackets.	Leaving jackets.		From Super-heater.	From Sample.
Aug. 9.	Lbs.	Deg.	Deg.	Deg.	Lbs.	Lbs.
11.15 A.M.	80.	401.	372.	342.		
.30	79.6	401.5	372.5	343.	34.25	31.
.45	79.7	401.5	372.5	343.		
12.00	80.1	401.	372.	342.5	35.5	31.5
.15	80.	400.5	372.	342.5		
.30	79.4	402.5	373.5	343.	34.25	31.
.45	80.3	402.5	373.5	343.		
1.00	80.4	402.	373.	343.	35.5	31.5
.15	80.	402.5	373.5	343.		
.30	79.6	401.	372.5	343.	34.5	31.95
.45	79.7	403.	373.5	343.		
2.00	80.1	402.	373.5	343.5	34.25	30.75
.15	79.6	401.	373.	343.		
.30	79.7	403.	373.5	343.5	34.5	30.75
.45	79.1	403.	373.5	343.5		
3.00	80.1	402.5	373.5	343.	34.75	30.75
.15	79.7	402.5	373.5	343.		
.30	79.7	402.5	373.5	343.5	34.75	30.5
.45	79.9	403.5	374.	344.		
4.00	79.6	404.	375.	344.	34.75	30.5
.15	79.2	399.	372.	342.		
.30	79.9	397.	370.	342.	35.	30.5
.45	79.6	398.5	371.	342.		
5.00	79.2	398.5	371.	342.	35.	30.5
.15	79.6	399.	371.	343.		
.30	79.2	397.5	370.	341.5	35.	30.5

CALORIMETER TEST. — *Concluded.*

TIME.	PRESSURE.	TEMPERATURE OF STEAM SUPPLIED BY SUPERHEATER.		Temperature of sample steam when discharged.	WEIGHT OF STEAM CONDENSED DURING PRECEDING HALF-BOUR.	
		Entering jackets.	Leaving jackets.		From Superheater	From Sample.
Aug. 9.	Lbs.	Deg.	Deg.	Deg.	Lbs.	Lbs.
5.45	79.2	308.	370.	341.5		
6.00	79.8	307.	370.	342.	34.75	30.75
.15	79.5	307.	370.	342.		
.30	79.8	308.	370.	342.	34.75	30.5
Aug. 10.						
8.15 A.M.	79.	307.	368.	340.		
.30	78.9	306.	368.	340.	35.	32.75
.45	79.6	306.5	369.	340.5		
8.00	79.	296.	368.	340.	34.75	33.
.15	79.2	305.	368.	340.		
.30	79.5	304.	367.5	340.	34.5	33.
Average and Totals . .	79.6	309.9	371.6	342.3	625.75	561.

*Calorimeter Tests, Chestnut-Hill Pumping-Station. Computations.*

	Degrees.
1 Superheat lost by jacket . . . . .	28.3
2 Superheat lost by jacket, corrected for 6 degrees of radiation . . . . .	22.3
3 Superheat lost by jacket, corrected for radiation and for ratio between steam used for superheater and that used for sample . . . . .	24.7
4 Superheat in sample steam when discharged . . . . .	18.8
5 Superheat in sample steam when discharged, corrected for 1.5 degrees of radiation from supply-pipe . . . . .	20.3
6 Superheat expended in evaporating the moisture contained in the sample leaving the main (line 3 minus line 5) . . . . .	4.4
7 Percentage of moisture (line 6 ÷ 18.7) . . . . .	per cent. 0.24

## WEIR MEASUREMENTS.

The following are extracts from the report on the weir measurements by Mr. Desmond Fitzgerald, Resident Engineer and Superintendent Western Division Boston Water Works.

*Description of Weir.*

The 30-inch force main from the pumps delivers into one end of a brick compartment in the gate-house at Fisher Hill. The weir was built into the other end of the compartment in such a manner that the water could discharge freely into the air. The surface of the water in the reservoir was maintained at a fixed height (grade 239.00), something over a foot below the crest of the weir, this being the height at which the correction for leakage from the chamber was made.

The elevation of the weir was 240.164. It was constructed free from end contractions. The sides consisted of a framework faced with boards planed smooth, free from irregularities, parallel and at right angles with the weir. The depth of the water for a considerable distance behind the weir was 20.24 ft., which gave an insignificant velocity of approach, and allowed the water to flow freely and smoothly to the weir. This action was still further aided by sets of screens placed near the delivery end of the force main. The lip was a steel straight edge, nickel plated, 0.0066 in thickness, carefully levelled, before and after each test, by a delicate bubble, made by Buff & Berger. The exact length was determined by a special brass rod fitted with sliding scale and vernier. The mean of a number of measurements made the length of the weir 5.008 ft.

*Hook Gauge.*

The hook gauge was arranged after the method recommended by Fteley and Stearns in their hydraulic experiments.

A plate was fitted normal to the current on the side of the box, at a distance of 6 ft. above the weir and 0.4 ft. below the crest. From the centre of the plate a rubber hose led to the gauge-chamber, which was conveniently placed in another compartment of the gate-house adjoining the weir chamber, and separated therefrom by a water-tight dam.

The 0 of the gauge was fitted level with the lip of the weir by means of the same apparatus used by Fteley and Stearns, and which gives a very delicate method of adjusting the levels. It is fully described and illustrated in the proceedings of the American Society of Civil Engineers.

*Observations.*

The heights of the water flowing over the weir were taken every five minutes throughout the duty trials by two observers, who alternated in descending into the chamber. Each observer checked the previous reading before taking a new observation. By this method errors were reduced to a minimum.

*Formula.*

In the general formula for flow over a weir with end contractions suppressed, the coefficient 3.35 was adopted from the Fteley and Stearns experiments on a weir of same length and about the same flow. The correction for the velocity of approach was computed after the method recommended by Hunking and Hart, and was found to be 1.00043 for August 9-10, and 1.00044 for September 26-27. For five minutes, or three hundred seconds, we have

$$\Sigma Q_g = 7.48 \times 300 \times 3.35 \times 5.008 \times 1.0004^3 \times \left( \Sigma H_m^{\frac{3}{2}} \right)$$

The following method was pursued in working out the details. The heights at the beginnings and ends of the 5-mt. periods were added and their mean taken for a new height  $= H_m$ .

The  $\frac{2}{3}$  power of this height was then found and placed in a column. The total sum of the number in this column gave  $(\Sigma H_m^{\frac{2}{3}})$  completing the numerical values in the above formula.

This process is somewhat laborious, but is believed to give results that will be found trustworthy.

#### The Tests.

The following is a brief summary of the test made on Aug. 9-10, 1888. Water arrived at weir at 10h. 21m., August 9, and ceased running at 10h. 13m., August 10.

Treating first the even periods of 5 mts., we have  $\Sigma H_m^{\frac{2}{3}} = 213.7545$   
 $\therefore \Sigma Qg = 7.48 \times 300 \times 3.35 \times 5.008 \times 1.00043 \times 213.7545$   
 $= 8,050,700$  gals.  
 Flow from 10h. 21m. to 10h. 25m., August 9 . . . 21,558 "  
 " " 10h. 10m. to 10h. 13m., " 10 . . . 16,964 "  
 Rise in weir box before normal flow . . . 1,661 "  
 Leakage (measured), main, gates, weir, etc. . . 21,842 "

Total . . . . . 8,112,725 gals.

The following extract from the log for one hour is sufficient to show the details, Aug. 9, 1888:—

Time.	H.	$H_m$ .	$H_m^3$ .	$H_m^{\frac{2}{3}}$ .	$\Sigma H_m^{\frac{2}{3}}$ .
12-00	0.833	0.8360	0.5843	0.7644	13.9576
05	0.824	0.8285	0.5687	0.7541	
10	0.837	0.8305	0.5728	0.7568	
15	0.834	0.8355	0.5887	0.7637	
20	0.835	0.8345	0.5811	0.7623	
25	0.860	0.8475	0.6087	0.7802	
30	0.858	0.8590	0.6338	0.7961	
35	0.848	0.8530	0.6207	0.7878	
40	0.823	0.8355	0.5832	0.7637	
45	0.852	0.8375	0.5874	0.7664	
50	0.828	0.8400	0.5927	0.7699	
55	0.801	0.8145	0.5408	0.7351	
13-00	0.807	0.8040	0.5197	0.7209	
					9.2005

The test of Sept. 26-27, 1888, was treated in a similar manner. It will be unnecessary to repeat the methods pursued. The following is a brief summary.

Water arrived at wier at 9h. 49½m., September 26, and stopped 9h. 50m., September 27, giving a total flow of . . . .	8,353,497 gals.
Add leakage and rise in wier box . . . .	23,503 "
Total . . . . .	8,377,000 gals.

### IRON PIER AT MARINE PARK.

Work on this pier was resumed on Feb. 20, 1888. The wooden-pile structure connecting the iron pier and the temporary wooden pier was completed on October 13, and the iron pier and its railings so far completed as to be opened to the public on Dec. 2, 1888.

A contract was made on Oct. 20, 1888, with Messrs. Shailer & Schniglaui, of Chicago, Ill., for furnishing four additional spans of iron pier, and work under this contract will be begun early in the coming spring.

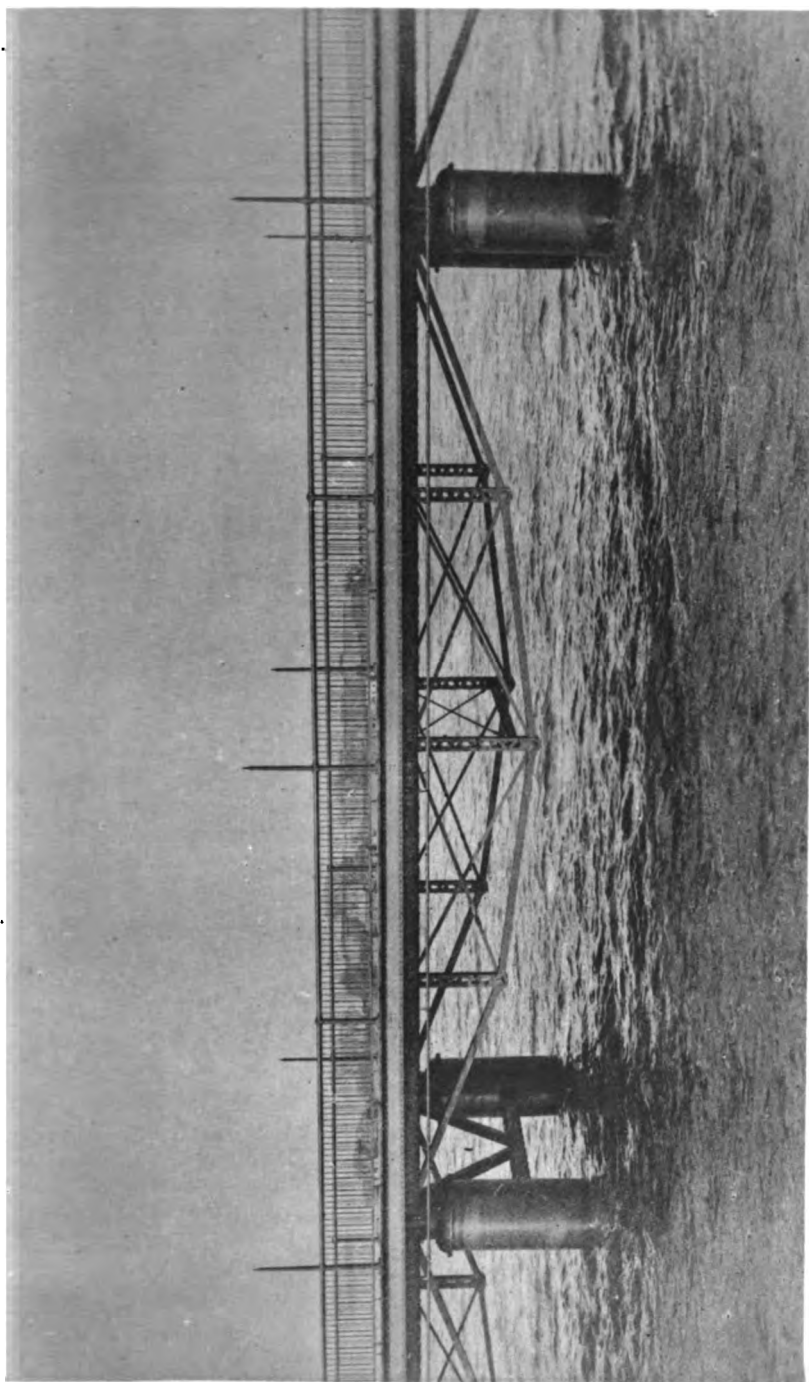
The portion of pier completed in December last comprised seventeen spans, or a total length of 1,049.75 ft.

The iron pier commences at the outer end of the temporary wooden pier built in 1886, a point about 1,250 ft. from the shore at mean high water, and is built with its centre line on the arc of a circle of 2,500 ft. radius, the pier curving toward the north. It is to be used exclusively as a promenade. The pier is 35 ft. 2 in. between centre lines of railings, and its floor is 24 ft. 6 in. above Grade O, City Base, which is approximately the level of mean low water. At mean low tide there is from 3 ft. to 6 ft. 6 in. depth of water on the line of the pier, with an additional depth of mud or soft material of from 24 ft. to 29 ft. The greatest distance from Grade O to hard bottom is 33 ft.

The so-called hard bottom is a very tough and compact clay, which is known to extend to a great depth in that portion of the harbor where the pier is located. The pier is made of iron deck-spans, supported on cast-iron cylinders or pier-piles, its general construction being shown in the accompanying view.

The pier piles are cast-iron cylinders, 4 ft. 6 in. outside diameter, and 1½ in. thick. They are made in lengths of about 8 ft., excepting the special top sections and those necessary to make up a required length of pile, and are provided with internal flanges. These flanges were faced and the joints between them filled with red lead before being bolted together.

The pier piles were placed 11 ft. each side of the centre line of the pier, and on lines radial to the same; the chord



437 N. 200.

IRON PIER AT MARINE PARK.  
VIEW OF ONE 60 FT. SPAN.

REUTERS PRINTING CO.



distance between these lines, at centre of pier, being 61 ft. 9 in.

The cylinders were sunk 8 ft. into the clay bottom, the soft material being removed by a dredging bucket, and the clay being dug and cut out by hand tools. The maximum length of pier piles from cap joint to bottom is 61 ft.

The mud and soft material is of such a nature as to prevent water from entering the cylinders while being sunk.

After a cylinder had reached the required depth, it was held in position vertically, and the clay dug out below it, forming an excavation, or pocket, about 7 ft. in diameter, and 2 ft. 6 in. to 3 ft. deep. This pocket, and about 8 ft. in length of the cylinder, was immediately filled with concrete. The work of digging and filling this pocket was done as quickly as possible, and the contractor was not allowed to begin it unless it could be carried forward without interruption. After the concrete in the pocket had become partially set, the work of filling the entire cylinder with concrete was proceeded with, the cross bracing attached, and the floor beams over cylinders and the truss-seat castings adjusted to proper position and grade, and bedded in the filling.

The concrete used in the work was made of Portland cement, sand, and broken stone, pebbles, or coarse gravel, in the following proportion:—

From bottom of excavation to Grade O, cement, 1 part; sand, 3 parts; stone, 7 parts.

From Grade O to Grade 15 ft., cement, 1 part; sand, 3 parts; stone, 5 parts.

From Grade 15 ft. to Grade 19 ft., cement, 1 part; sand, 2 parts; coarse gravel, 5 parts.

Mortar made of 1 part cement and 2 parts sand was used for the rest of the cylinder, and the filling of the cap and truss-seat castings was completed with tar roofing compound, to make the work water-tight.

The superstructure of the pier consists of wrought-iron deck-spans. Each span has two pin-connected trusses, of the inverted bow-string type, each 60 ft. long between centres of end pins, and 7 ft. 6 in. deep at middle. Floor beams are built iron girders, those over pier piles being double webbed and connected to wrought-iron posts built into the cylinders.

Floor joists are hard pine, and the floor planking is one course of 2-in. clear hard pine, planed on one side to an even thickness and jointed, laid diagonally.

The railings are of wrought-iron, with the exception of the posts over the floor beams, which are cast-iron. Every



alternate post extends above the railing, and is fitted with a gas lamp.

The Builders Iron Foundry, of Providence, R.I., were the contractors for the work, and the amount paid them for the seventeen spans of pier complete was \$134,664.33.

#### NORTH PAVING WHARF.

The work of rebuilding this wharf, which was under contract at the beginning of the year, was completed in April. It is a substantial wharf, built with oak piles, hard-pine timber, and kyanized spruce covering. The wharf and platform adjoining it covers an area of 9,100 square feet.

#### PROPOSED BRIDGE TO EAST BOSTON.

The City Council, by an order approved by the Mayor Dec. 24, 1888, directed the City Engineer to prepare plans and estimates for the construction of a bridge to connect East Boston with the city proper.

In past years approximate estimates had been made for this purpose from the data available, and it was presumed that the purpose of the Council's order was to obtain more definite plans and estimates. To do this it is necessary to first obtain by proper surveys and borings definite facts to work from, and the City Council will consequently be asked to appropriate the sum of \$2,500, which will be required to obtain this information.

#### QUINCY-STREET BRIDGE.

The railroad bridge over Quincy street, built by the New York & New England Railroad, at the joint expense of the road and city, and to the approval of the City Engineer, has been finished. It is a plate girder bridge of 38 feet span, carried on stone abutments laid solid in cement mortar on a spruce-pile foundation. The cost to the city was \$5,421.17.

#### SEA-WALL ON ROXBURY CANAL.

The city's wharf, adjoining the south yard of the Water Department, has been added to the pipe-yard, and the wall on Roxbury Canal has been rebuilt in a similar manner to the wall built last year on the old part of the wharf. The masonry plans and specifications were prepared by this department, and the work was done by Charles E. Edwards. It was finished in August and cost \$5,965.90.

**WATER-PIPE BRIDGE.**

The Water-Pipe Bridge, between Charlestown and Chelsea, the rebuilding of which was begun last year, was completed in April. Total cost of bridge and boxing, \$14,928.04. The structure was described in the last annual report.

Other work of a miscellaneous character was principally as follows:—

*Plans and Specifications.*

For Superstructure of Wood Island Park Bridge.

- “ Extension of Iron Pier, Marine Park.
- “ Water-pipe under railroad tracks on Travers street.
- “ Fence at Charles River Embankment.
- “ “ “ Marine Park Pier.
- “ “ “ Gymnastic Grounds, Charles River Embankment.
- “ Connecting Iron and Wooden Piers, Marine Park.
- “ Water Tank, Breed's Island.
- “ Athletic Apparatus, Charles River Embankment.
- “ Coal House Roof, Mystic Pumping-Station.
- “ Rebuilding the City's Wharf, No. 600 Albany street.

*Estimates.*

For Foot Bridge at Camden street.

- “ “ “ “ Berwick Park.
- “ Bridges over N.Y. & N.E. R.R., South Boston Flats.
- “ Abutments and Bridge on Leyden street.

The usual large amount of work of a general character has been done during the year. Under this head may be classed record-plans, maps for Water-Works and Park Department, copying, tracing, and blue-printing plans.

## SPECIAL EXAMINATION OF PILING.

During the year an examination of the piling under portions of eleven bridges was made by a diver, under the direction of Assistant Engineer Henry Manley, to find the damage done by the *Limnoria*, or pile-worm, with substantially negative results; in only two cases was serious damage found, and these were both previously known. In fact, cases of serious damage can usually be discovered by an examination at low water of spring tides. The two cases referred to were the draw pier of Broadway bridge

and the draw foundation of Chelsea-street bridge: Winthrop bridge is badly damaged by the *Limnoria*, and was repaired by driving new piles, in 1887. In this case the bridge is left nearly dry at extreme low water, and its condition can be seen. (For particulars see notes on these bridges.)

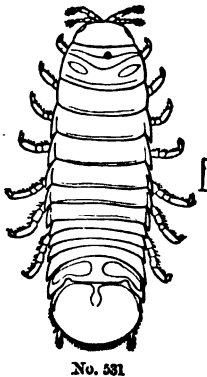


Figure 2.—*Limnoria lignorum*; dorsal view, enlarged 100 diameters.

The diver also examined the wharves at Deer, Rainsford, and Gallop's islands. Gallop's-island wharf is but slightly affected. Rainsford and Deer island wharves are both seriously damaged, and should be examined at intervals of one or, at the most, of two years, and repairs made when found necessary. No repairs on account of damage from this source are required at present; both these wharves have been once rebuilt because

of the destruction of their piling by the *Limnoria*.

There are three marine animals on the Atlantic coast of the United States that do serious damage to submerged wood-work. Only one of them, the *Limnoria terebrans*, as it is called in most works on the preservation of timber, or *Limnoria lignorum*, as it is called by naturalists, is found in this harbor in considerable numbers. It is not found in brackish waters, and water contaminated with sewage is not favorable to it. It is most met with in the clear waters of the lower harbor, being found in abundance at Deer island and Rainsford island, although for some unknown reason but few are found at Gallop's island.

Spruce and soft woods are rapidly eaten; while oak piles endure much longer. The wharf at Deer island (of oak), which was rebuilt in 1879, because of their ravages, had been built twenty-four years.

The following account is taken from "The Fisheries and

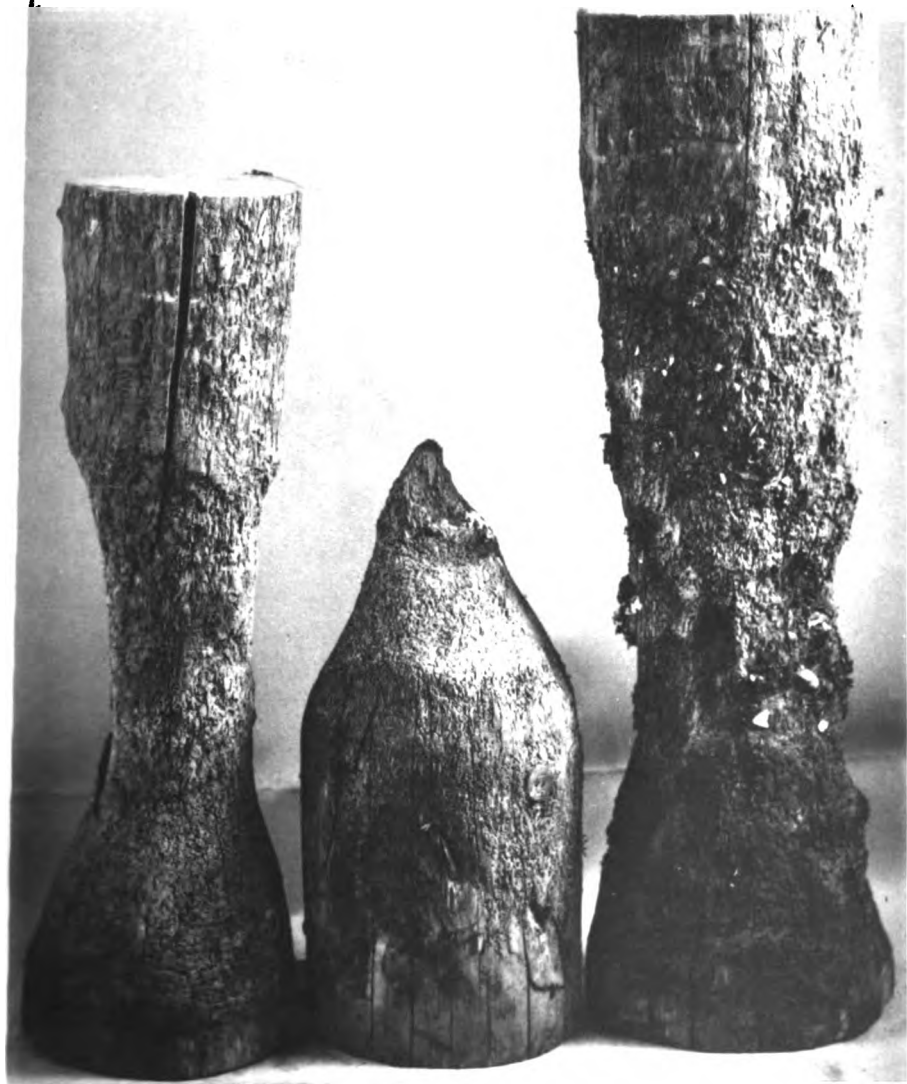


BOSTON, MASS.

OAK PILE 23 FT. LONG, 16 INS. DIAMETER, REDUCED IN SIZE BY THE LIGNORIA TENETRANS.

HELIOTYPE PRINTING CO.





RELIO TYPE PRINTING CO.

BOSTON MASS.

SPRUCE PILKS DESTROYED BY THE LIMNORIA TEREBRANS.



Fishery Industries of the United States," by Geo. Brown Goode, 1884, a publication of the United States Fish Commission : —

THE GRIBBLE, OR BORING LIMNORIA — LIMNORIA LIGNORUM,  
WHITE.

"The little crustacean pest, which measures less than one-fifth of an inch in length, is a very common inhabitant of our Atlantic coast from the Gulf of St. Lawrence to Florida, and also occurs abundantly on the coast of Great Britain and of other parts of Europe. In spite of its small size, it is very destructive to all kinds of sub-marine wood-work, which it rapidly eats away. Its body, which is sub-cylindrical in shape, consists of fourteen segments, the anterior one being the head ; the two ends are rounded and the sides are nearly straight and parallel to one another. The first seven segments, not including the head, bear each a pair of short legs. It makes its burrows by means of stout mandibles or jaws. In color it is grayish, the upper surface of the body being covered with minute hairs, to which more or less dirt usually adheres.

"The Gribble generally lives above and just below low-water mark, but has been found at times, though very rarely, as low down as seven to ten fathoms. It gnaws burrows into all sorts of sunken or floating wood near the shore, and lumber or drift-wood left for some time on muddy shores is pretty certain to be attacked by it. The burrows are made to a depth of about half an inch, and when they become numerous enough to reduce the superficial layer of wood to a mere honey-comb, it scales off, leaving a fresh surface, which is at once attacked. Much damage is done by this little creature to the piles of wharves and other sub-marine wood-work all along our Atlantic coast, and numerous methods of stopping its ravages have been devised. It has been observed attacking the gutta percha of submarine telegraph cables. Professor Verrill describes its habits and the damage it has done on the American coast, as follows : 'It has the habit of eating burrows for itself into solid wood to the depth of about half an inch. These burrows are nearly round, and of all sizes up to about a sixteenth of an inch in diameter, and they go into the wood at all angles, and are usually more or less crooked. They are often so numerous as to reduce the wood to mere series of thin partitions between the holes. In this state the wood rapidly decays, or is washed away by the waves, and every new surface exposed is immediately attacked, so that layer after layer is rapidly removed, and the



timber thus wastes away and is entirely destroyed in a few years. It destroys soft woods more rapidly than hard ones, but all kinds are attacked except teak. It works chiefly in the softer parts of the wood, between the hard, annual layers, and avoids the knots and lines of hard fibre connected with them, as well as rusted portions around nails that have been driven in, and consequently, as the timber wastes away under its attacks, these harder portions stand out in bold relief.

"Where abundant it will destroy soft timber at the rate of half an inch or more every year, thus diminishing the effective diameter of piles about an inch annually. Generally, however, the amount is probably not more than half this; but even at that rate the largest timbers will soon be destroyed, especially when, as often happens, the *Teredos* are aiding in this work of destruction. It lives in a pretty narrow zone, extending a short distance above and below low-water mark. It occurs all along our shores, from Long Island sound to Nova Scotia. In the Bay of Fundy it often does great damage to the timbers and other wood-work used in constructing the brush fish-weirs, as well as to the wharves, etc. At Wood's Holl it was found to be very destructive to the piles of the wharves. The piles of the new government wharves have been protected by broad bands of tin-plate covering the zone which it chiefly affects. North of Cape Cod, where the tides are much greater, this zone is broader, and this remedy is not so easily applied. It does great damage also to ship timber floating in the docks, and greater losses are sometimes caused in this way. Complaint of such ravages in the navy-yard at Portsmouth, N.H., have been made, and they also occur at the Charlestown navy-yard and in the piles of the wharves at Boston. Probably the wharves and other submerged wood-work in all our seaports, from New York northward, are more or less injured by this creature, and, if it could be accurately estimated, the damage would be found surprisingly great.

"Unlike the *Teredo*, this creature is a vegetarian, and eats the wood which it excavates, so that its boring operations provide it with both food and shelter. The burrows are made by means of its stout mandibles, or jaws. It is capable of swimming quite rapidly, and can leap backward suddenly by means of its tail. It can creep both forward and backward. Its legs are short and better adapted for moving up and down in its burrow than elsewhere, and its body is rounded, with parallel sides, and well adapted to its mode of life. When disturbed it will roll itself into a ball. The



HELIO TYPE PRINTING CO

BOSTON MASS.

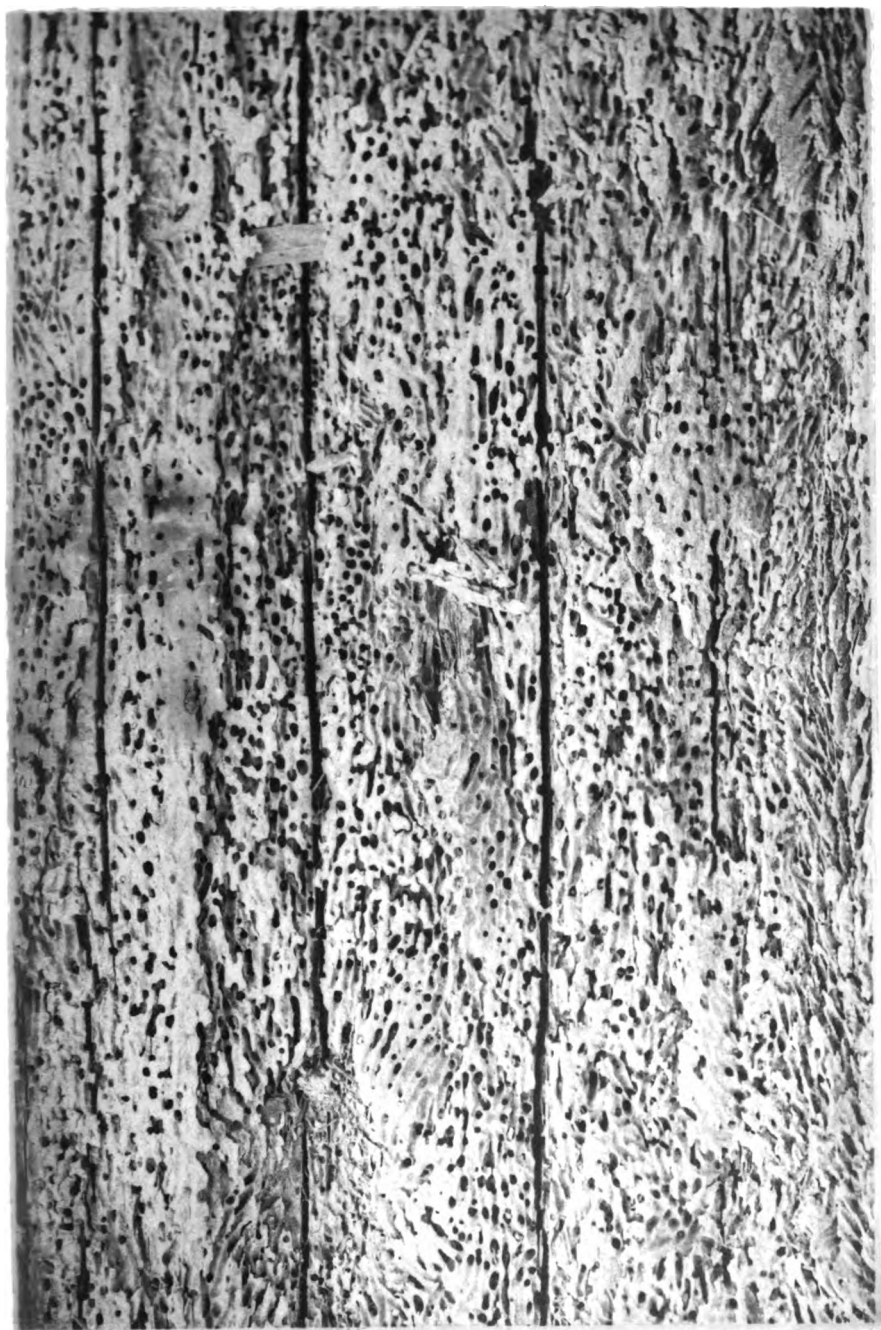
NO. 1.

NO. 2.

NO. 1.—SPRUCE PILE ATTACKED BY THE LIMNORIA TEREBRANS. THE LOWER PART SHOWS THE PILE UNINJURED, WHERE IT WAS UNDER THE MUD.

NO. 2.—HARD PINE TIMBER ATTACKED BY THE LIMNORIA.





HELIO TYPE PRINTING CO.

BOSTON, MASS.

SURFACE OF SPRUCE PILE ATTACKED BY THE LIMNORIA TEREDRANS. FULL SIZE.





HELIO TYPE PRINTING CO.

BOSTON, MASS

SURFACE OF HARD PINE ATTACKED BY THE LIMNORIA TEREBRANS. FULL SIZE.



female carries seven to nine eggs or young in the incubatory pouch at one time.

"The destructive habits of this species were first brought prominently to notice in 1811, by the celebrated Robert Stephenson, who found it rapidly destroying the wood-work at the Bell Rock Light-house, erected by him on the coast of

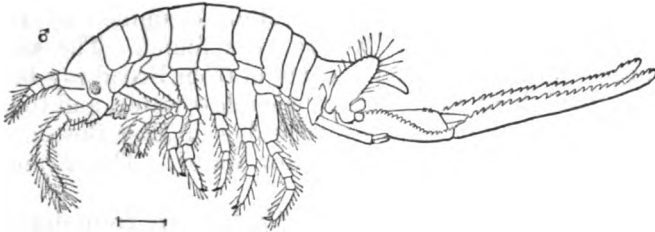


Figure 1.—*Chelura terebrans*; male; lateral view, enlarged about twelve diameters.

Scotland. Since that time it has been investigated, and its ravages have been described by numerous European writers. It is very destructive on the coast of Great Britain, where it is known as the "Gribble."

"The remedies used to check its ravages are chiefly copper or other metallic sheathing; driving broad-headed iron nails, close together, into the part of the piles subject to their attacks; and applying coal-tar, creosote, or verdigris-paint once a year or oftener."

The two remaining animals referred to are the *Teredo navalis*, or ship-worm, and the *Chelura terebrans*. The *Teredo* is found in warm climates in nearly all parts of the world. In appearance it is a large soft worm, and may grow to the length of eighteen inches and to a diameter of three-eighths of an inch; it burrows in the interior of the timber, and when it is numerous the timber is soon reduced to a mere shell. It is abundant on the southern coast of Massachusetts, but is not found north of Cape Cod.

Of the *Chelura*, the authority already quoted says:—

"This very destructive little crustacean, which is of common occurrence on the European coast, from southern Norway to the Adriatic Sea, has so far been noticed on the Atlantic coast of the United States at only two places, Wood's Holl and Provincetown, Mass.

"At both of these localities it was found associated with the 'gribble' (*Limnoria lignorum*), in the submerged piles of old wharves. It is more than possible, however, that it is a common inhabitant of our coast, doing a certain amount of the damage hitherto ascribed to other boring animals. Without



a careful examination, it is quite easy for an unskilled eye to confound *Chelura* with *Limnoria*, although they belong to very distinct divisions of the *Crustacea*."

Specimens of timber secured by the diver from two localities infested by the *Limnoria* were submitted to Prof. S. I. Smith, of New Haven (who first identified the *Chelura* in this country), and to Professor Hyatt, of the Boston Society of Natural History, and were carefully examined by them, but no specimens of the *Chelura* were found. The sample of spruce timber examined was taken from Broadway bridge at a depth of about fourteen feet below low water, and the oak timber came from Chelsea-street bridge in East Boston at a depth of about twenty feet at low water. The *Limnoria* was abundant in each case.

The cuts of the *Limnoria* and *Chelura* are from drawings by Professor Smith, and were furnished by the kindness of the Secretary of the Smithsonian Institution of Washington.

The heliotypes, showing the manner in which the *Limnoria* does its work, were made from piles taken up by the Boston Tow Boat Company from its wharf in East Boston.

The heliotype of the oak pile twenty-six feet long, shows that the part which was under the mud is uninjured, while the originally larger part, which was above the mud and exposed to the action of the *Limnoria*, has been greatly reduced in size.

## B. — WATER WORKS.

## SOURCES OF SUPPLY.

The rainfall during the first seven months of the year was a little below the average, but since August 1 it has been unusually heavy, the total rainfall for the year at Lake Cochituate being the largest recorded since 1869.

The rainfall and quantities collected on the several watersheds are as follows :—

	Sudbury.	Cochituate.	Mystic.
Rainfall, inches,	57.465	56.93	56.745
“ collected inches,	35.749	30.97	31.12
Daily average yield, gallons,	127,642,900	27,751,400	25,001,600

The quality of the water from the Sudbury and Cochituate supplies has been good, and that from the Mystic has caused less complaint than usual.

The fluctuations in the amount of storage in the different lakes and reservoirs are shown graphically by an appended diagram. The condition of the different reservoirs during the year is given below :—

## CONSUMPTION.

The daily average consumption from the combined works has been as follows :—

	Cochituate Works.	Mystic Works.	Totals.
January . . . . .	40,485,700	11,107,100	51,592,800
February . . . . .	43,106,000	11,620,900	54,725,900
March . . . . .	36,463,400	9,242,000	45,705,400
April . . . . .	31,473,800	7,276,700	38,750,500
May . . . . .	30,902,000	6,932,300	37,734,300
June . . . . .	31,028,100	7,615,200	38,641,300
July . . . . .	32,014,400	8,267,500	40,281,900
August . . . . .	32,482,700	7,859,100	40,291,800
September . . . . .	31,536,500	7,266,300	38,102,800
October . . . . .	29,110,800	7,096,400	36,207,200
November . . . . .	28,590,900	6,990,800	35,581,700
December . . . . .	32,686,200	7,918,600	40,604,800
Averages . . . . .	32,310,700	8,258,400	41,569,100

The daily average consumption per head of population has been as follows : —

Sudbury and Cochituate supply . . . . .	88	gallons.
Mystic supply . . . . .	76.5	"
Total supply . . . . .	85.4	"

The above figures show an increase of 11.6 per cent. in the consumption from the Sudbury and Cochituate works over that of the year 1887, of 8.2 per cent. from the Mystic works, and of 10.9 per cent. from the combined supplies. The increase of consumption is large, and is mainly due to the long-continued cold weather in the early months of the year, the increase during the latter months not exceeding the rate of increase of the population.

#### SUDBURY-RIVER RESERVOIRS AND LAKE COCHITUATE.

*Reservoir No. 1.* — Water was wasting at the dam on January 1, and, with the exception of two days in January, continued to waste until June 8, when the stop planks were placed upon the dam. On June 28 wasting began again, and continued until July 13. The surface of the reservoir continued near high-water mark the balance of the season, waste beginning again on August 23, and continuing until the present time.

*Reservoir No. 2.* — This reservoir was full until June 24 ; it then gradually fell until August 4, when the surface of the water had fallen to grade 160.53, or 6.6 feet below the top

of the flash-boards, which was the lowest point reached during the year. Water has been flowing over the dam from September 23 to the present time.

*Reservoir No. 3.* — Water was flowing over the dam from January 1 to January 25, from February 22 to February 23, from March 28 to June 6, from June 26 to July 10, and from August 24 to the present time. The lowest point reached during the year was on March 20, when the surface of the water was at grade 169.41, or 5.83 feet below the crest of the dam.

*Reservoir No. 4.* — On Jan. 1, 1888, the water in the reservoir stood at grade 207.89, or 7.32 feet below the top of the flash-boards. The reservoir gradually filled during January and February, and the water remained in the vicinity of high-water mark until the 1st of August, when the reservoir was drawn upon to supply the city. On August 21 the water was at grade 211.20, and after that date it began to rise, reaching the top of the stop-planks on September 28. Since that date the reservoir has remained practically full.

*Farm Pond.* — The surface of this pond has been kept at an average level of 149.11 feet above tide-marsh level.

The conduit through the pond was in use from June 23 to July 10, and from December 15 to December 31. During the balance of the year the water was taken through the pond.

The Framingham Water Company has pumped 61,500,000 gallons from the pond, or a daily average of 168,033 gallons.

*Lake Cochituate.* — On Jan. 1, 1888, the surface of the lake was at grade 125.63, or 8.73 feet below high water. It began to rise during the latter part of February, until, on March 31, it reached grade 131.20, but soon began to fall.

Excepting August, water was wasted at the outlet of the lake during a part of each month, from March to December, inclusive, so as to allow the work to be done at the Pegan meadows.

On August 20, a contract was made with Auguste Saucier for the removal of 60,000 cubic yards of material on Pegan meadows for the improvement of the shallow flowage, so as to give a depth of 6 feet on the meadows at high water.

The accomplishment of this work was attended with much difficulty, on account of the unusual amount of rainfall, and the contractor is to be complimented for the fidelity with which he has carried out his agreement.

The plans for building a new dam at the outlet of the lake have been revised during the year, and late in the season the work of construction was commenced; but the necessity

of wasting large volumes of water, in order to allow the work on the Pegan meadows to be completed, has delayed the work, and, excepting the coffer dam, but little has been done.

Water has been drawn from the different reservoirs on Sudbury river to supply the city, as follows : —

	Reservoir No. 1. Top of flash- boards, 159.29.	Reservoir No. 2. Top of flash- boards, 167.12.	Reservoir No. 3. Crest of dam, 175.24.	Reservoir No. 4. Top of flash- boards, 215.21.	Farm Pond.	Lake Co- chituate. Top of flash boards, 134.36.
Jan. 1, 1888 . . . . .	157.79	165.94	175.46	207.89	149.24	125.63
Feb. 1, " . . . . .	157.59	166.25	174.28	211.67	149.21	125.70
March 1, " . . . . .	158.05	166.20	173.40	215.21	149.22	128.84
April 1, " . . . . .	158.52	166.29	175.49	213.80	149.17	131.16
May 1, " . . . . .	157.87	166.04	175.37	214.64	149.25	130.02
June 1, " . . . . .	157.97	166.16	175.52	215.17	149.28	130.12
July 1, " . . . . .	159.40	166.17	175.38	215.14	149.25	128.59
Aug. 1, " . . . . .	158.58	161.25	173.49	215.09	149.28	126.48
Sept. 1, " . . . . .	159.34	163.88	175.82	211.92	149.24	126.11
Oct. 1, " . . . . .	158.08	167.39	175.62	215.20	147.46	128.08
Nov. 1, " . . . . .	156.62	167.39	175.63	215.18	149.27	127.84
Dec. 1, " . . . . .	156.68	166.67	175.72	214.79	149.28	129.90
Jan. 1, 1889 . . . . .	158.07	166.24	175.58	214.61	149.25	130.71

*Reservoir No. 2, Jan. 1 to 22 inclusive.*

June 23 to July 9 inclusive.

July 25 to September 12 inclusive.

September 17 to September 26 inclusive.

September 29 to October 15 inclusive.

October 21.

*Reservoir No. 3, January 31 to June 7 inclusive.*

November 3 to December 12 inclusive.

*Reservoirs Nos. 2 and 3, January 23 to 30 inclusive.,*

June 7 to 20 inclusive.

July 10 to 24 inclusive.

*Reservoirs Nos. 2 and 3, September 16 to 20 inclusive.*

September 22 to November 2 in-  
clusive.

December 13 to December 31 in-  
clusive.

*Farm Pond, January 1 to June 23.*

July 10 to December 15.

### AQUEDUCTS AND DISTRIBUTING RESERVOIRS.

The Sudbury-river aqueduct has been in use during the whole or portions of 362 days, and the Cochituate aqueduct has been in use 358 days. The former has delivered into Chestnut-Hill and Brookline reservoirs 7,224,700,000 gallons, equal to a daily average supply of 19,739,600 gallons, and the latter has delivered 4,968,503,100 gallons, or 13,575,100 gallons per day.

Both aqueducts have been cleaned during the year; the details of this work will be found in the report of the Superintendent of the Western Division.

In the Cochituate aqueduct, from February 22 to June 27, and from September 27 to December 31, a depth of 6 feet of water was run; from June 27 to July 8, a depth of 6 feet 6 inches was run; for the balance of the year the depth of water run in the aqueduct followed the level of the lake.

The Chestnut-Hill, Brookline, Fisher-Hill, Parker-Hill, and East Boston reservoirs are in good condition.

Fisher-Hill reservoir has been in use during the whole year. The grading of the grounds was finished during the early part of the summer, a drain-pipe was laid from the back side of the reservoir lot to connect with the drain in Fisher-Hill avenue, shrubs were planted, the walks and slopes resurfaced, and the slopes and grounds seeded with grass.

The loam surfacing of the slopes slipped in three or four places during the very severe storm of September 26, and another small slip occurred during the storm of November 26. These slips are common to new embankments with a clayey subsoil, but will not probably occur after a strong sod has formed.

Parker-Hill reservoir was shut off from the distribution, and the high-service districts were supplied directly from Fisher-Hill reservoir from Dec. 3, 1887, to July 2, 1888. Since that date a circulation has been kept up in the reservoir by throttling the inlet gate.

West Roxbury has been supplied directly from Fisher Hill during the entire year.

### HIGH-SERVICE PUMPING-STATIONS.

The Elmwood-street pumping-station was discontinued on May 8, at 11 P.M., after having been in use since March 1, 1870, and the force of engineers and firemen was transferred to Chestnut Hill. The daily average amount pumped at this station, from January 1 to May 8, was 3,659,400 gallons.

The Brighton pumping-station was closed in January, and the engineer transferred to Chestnut Hill. The pumps have been taken down, and one of them will be transferred to the new station at East Boston to pump the water for the Breed's Island high service.

The Brighton pumping-station was built in 1876 for the temporary supply of the high-service district of Brighton until the Chestnut-Hill pumping-station should be built.

At the East Boston station the daily average amount pumped from January 1 to October 30 was 353,200 gallons; since the last date, with the exception of one day in December, no water has been pumped, as, on account of the increased supply furnished by the new 24-inch main, the reservoir can be filled from the low-service mains at night. During extreme cold weather pumping will have to be resorted to.

At the West Roxbury pumping-station the daily average amount pumped was 40,560 gallons. The daily amount of water used varied from an average of 20,800 gallons in April to 74,800 gallons in January, but nearly one-half of the apparent consumption during the winter months was due to the opening of a connection between the West Roxbury high service and the general high service to prevent the freezing of the water in the pipe over the Park-street bridge.

The tank on Bellevue Hill has been enclosed by an observatory tower, which it is expected will prevent any trouble from ice in the tank.

#### NEW HIGH-SERVICE WORKS.

Work upon the pumping-machinery and boilers was so far advanced January 21 that fires were started under one of the boilers, and engine No. 1 was run for a short time.

On February 1, engine No. 2 was started, and they were run irregularly nearly every day until May 9, when they were put into regular service, the pumps at Elmwood street being abandoned. The pumps are completed, excepting some minor details and painting.

A duty trial was made of engine No. 1, together with boiler No. 2, on August 9 and 10, and trials were made of engine No. 2, with boiler No. 1, on August 22 and 23, and on September 26 and 27. See details on pages 22-36.

*Amount of water pumped at Elm-street and Chestnut-Hill pumping-stations in 1888.*

	Elmwood street.	Chestnut Hill.	Total.
January . . . . .	141,970,300	2,271,500	144,241,800
February . . . . .	118,072,000	31,011,875	149,083,875
March . . . . .	102,284,500	35,349,850	137,634,350
April . . . . .	92,287,000	31,643,175	123,930,175
May . . . . .	20,444,500	107,400,500	127,845,000
June . . . . .	.....	144,288,925	144,288,925
July . . . . .	.....	171,114,750	171,114,750
August . . . . .	.....	170,841,875	170,841,875
September . . . . .	.....	160,001,215	160,001,215
October . . . . .	.....	157,559,500	157,559,500
November . . . . .	.....	151,792,250	151,792,250
December . . . . .	.....	170,032,100	170,032,100
Daily average amount pumped . . . . .	.....	.....	4,932,700 gallons.

In June several districts were changed from low service to high service. In the city proper, 3.5 miles of streets were so changed; in Roxbury, 3.9 miles; in Dorchester, 2.2 miles; and in West Roxbury, 0.6 miles.

The amount of water used by the high service increased from 3,691,000 gallons per day in 1887 to 4,932,700 gallons in 1888; the increase during the last half of the year, after the territory supplied was enlarged, being 1,597,600 gallons per day, or 42.8 per cent. over the consumption for the corresponding months in 1887.

## DESCRIPTION OF CHESTNUT-HILL PUMPING-STATION.

The buildings consist of an engine-room 84 feet 10 inches by 64 feet 8 inches, with a basement; a boiler-room, 79 feet 10 inches by 56 feet 2 inches; and a coal-room 65 feet 4 inches by 62 feet, connected with the boiler-room by an extension 43 feet 8 inches by 19 feet 10 inches.

West of the pumping-station is a circular screen-chamber, which is connected with the Cochituate aqueduct by a brick conduit 4 feet by 4 feet 4 inches in section, and with the 48-inch pipe from the Sudbury conduit by a 36-inch iron pipe. A third connection can be made with Chestnut-Hill reservoir by a 48-inch pipe when desired, the pipe for this connection being laid from the screen-chamber to the centre of Beacon street. Through these connections water can be



drawn directly from either the Cochituate or the Sudbury conduit, or from the reservoir, as may from time to time seem best.

Double screens made of copper wire can be placed in grooves built into the masonry, and iron sluice-gates and stop-planks are arranged for controlling the flow of the water.

A brick conduit 4 feet by 5 feet in section connects the screen-chamber with the pump-wells in the basement of the engine-room. There are three wells; two of them are each 18 feet by 10 feet and 16 feet deep, and the third, which was provided for a future pumping-engine, is 21 feet by 10 feet by 16 feet.

These wells are connected with the conduit through 3 feet by 3 feet iron sluice-gates.

In order to provide for the possible extension of the engine-room for a fourth pumping-engine, a gate-opening for a proposed pump well has been built into the foundation wall on the west end of the building, and the bottom of a foundation wall between the present building and the screen-chamber has been built, so that an extension to the present building can be built at any time without interfering with the operation of the present pumping-plant.

Each well can be emptied through a 12-inch drain-pipe, which also receives the waste water from the condensers of the engines.

The basement has a concrete floor, and in it will be fitted up a repair shop.

The pumping plant consists of two Gaskill horizontal compound engines, each having a capacity of 8,000,000 gallons in 24 hours; they were built by the Holly Company, of Lockport, N.Y.

The high-pressure cylinders are 21 inches diameter, the low-pressure cylinders 42 inches diameter, the water-plungers 25 inches diameter, and all have a stroke of 36 inches. The plunger displacement is 302 gallons per revolution, and the maximum piston speed, as per contract, is 115 feet per minute. The foundation of each pump consists of a solid block of American cement concrete 14 feet 5 inches in thickness, and on each foundation are built four brick piers 6 feet 8 inches high, surmounted by a granite coping 12 inches in thickness. The engines and pumps are secured in position by 1½-inch bolts, which are built into the entire depth of the brick foundations. The force mains from each pump are 24 inches in diameter, and they unite outside of the building with a 30-inch pipe, which extends to Fisher-Hill reservoir, — a distance of 5,800 feet. Branches and gates have been placed in the force main, so that a third and fourth pumping-engine can be

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connected with the force main without stopping the pumping. Branches have also been located for a second force main.

The steam is furnished by two horizontal tubular steel boilers, 78 inches in diameter, 18 feet 5 inches long. The shell is  $\frac{7}{8}$  inch thick, and each boiler contains 151 tubes, 3 inches in diameter. Each boiler contains 2,171 square feet of heating surface and 49 square feet of grate surface. A feed-water heater is placed in the flue between the boilers. It is made of 80 brass tubes, each  $2\frac{1}{2}$  inches diameter and 15 feet long, supported by racks on a portable carriage. It has a heating surface of 931 square feet. The main steam-pipe from the boilers to the engine-room is 10 inches in diameter. The smoke-flue from the boilers to the chimney is of brick, and is carried under the floor of the boiler-room.

The chimney is located in the extension of the coal-house. It is 150 feet in height above the floor of the boiler-room, and the foundations extend to solid earth at a depth of 26 feet. The foundation is 27 feet 10 inches square at the bottom, and is stepped in to 20 feet square at the grade of the bottom of the flue where the brick masonry begins.

The foundation is of Portland cement concrete to a height of 6 feet above its base, and the upper portion is of rubble masonry laid solid in American cement mortar. A door is placed in the chimney at its base for the removal of soot, and an opening for a second smoke-flue has been built and bricked up until needed. The chimney is drawn into a circular form above the opening for the flues. The outside shell at the base is 15 feet in diameter and is 28 inches thick; it has an outside batter of 0.288 inches per foot, and its thickness is gradually reduced to 16 inches at a point 96 feet above the floor. The flue is circular, its inside diameter is 5 feet 6 inches, and its wall is 12 inches thick at the base and 4 inches at the top, which is 20 feet below the top of the outside shell. The chimney has a cast-iron cap, and is fitted with two  $\frac{1}{2}$ -inch copper lightning-rods.

The coal-room contains four bins, 51 feet long, 14 feet 6 inches wide, and 13 feet high; they will hold about 1,000 tons of coal.

The coal is raised to an elevated run, from which it is dumped into the bins. Scales are provided so that the coal can be weighed before dumping.

#### EAST BOSTON AND BREED'S ISLAND HIGH SERVICE.

The works will soon be in working order. The pumping-station is built of brick, with brown-stone trimmings, and is located on Condor street, nearly opposite Brooks street.

The supply is taken through a 16-inch suction-pipe, which connects with the 24-inch pipe which crosses Chelsea creek near this point.

A 12-inch force main is laid from the pumping-station to the reservoir on Brooks street; and another 12-inch force main is laid from the pumping-station, a distance of 11,000 feet, to a wrought-iron tank on the summit of Breed's Island, or Orient Heights. This tank is 24 feet in diameter and 40 feet high. The bottom of the tank is 154.60 feet above water-works base.

The two pumps now located in the old pumping-station at the reservoir lot will be moved into the new building to furnish the supply for the East Boston high service, and one of the pumps from the discontinued Brighton pumping-station will be used for the Breed's Island service.

The piping is so arranged that all the pumps can be used for either district.

Contracts for this work have been made as follows : —

Pumping-station, Donahue Bros. & Co. . . .	\$8,650 00
Pump foundations, J. H. Etridge, Nov. 10, 1888, . . .	316 25
Boilers, — two, — E. Hodge & Co., Nov. 30, 1888 . . . . .	838 00
Tank, George Miles, March 13, 1888 . . . . .	2,420 00

The foundations of the tank and the laying of the water-pipe were done by the day.

#### MYSTIC LAKE.

Water was wasted over the dam from January 1 to January 22, from February 5 to February 9, from February 20 to June 3, from June 14 to June 16, and from September 26 to December 31.

The lowest point reached during the year was on September 17, when the surface of the lake was at grade 4.26, or 2.74 feet below high water.

#### MYSTIC-VALLEY SEWER.

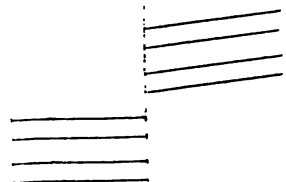
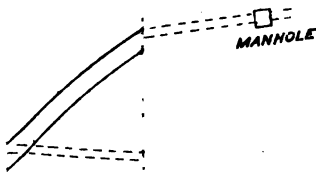
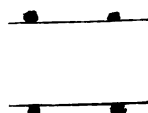
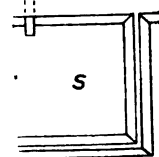
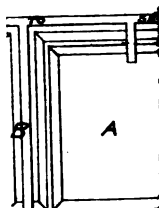
The new settling-tanks have been completed and are in successful operation. The works consist of a pump well connected by a brick sewer with the main sewer, a sewage-pump, an engine, an engine-house, four settling-tanks, a sludge-well, a sludge-pump, and a series of settling-basins for receiving the sludge.

ON WATER

MYSTIC

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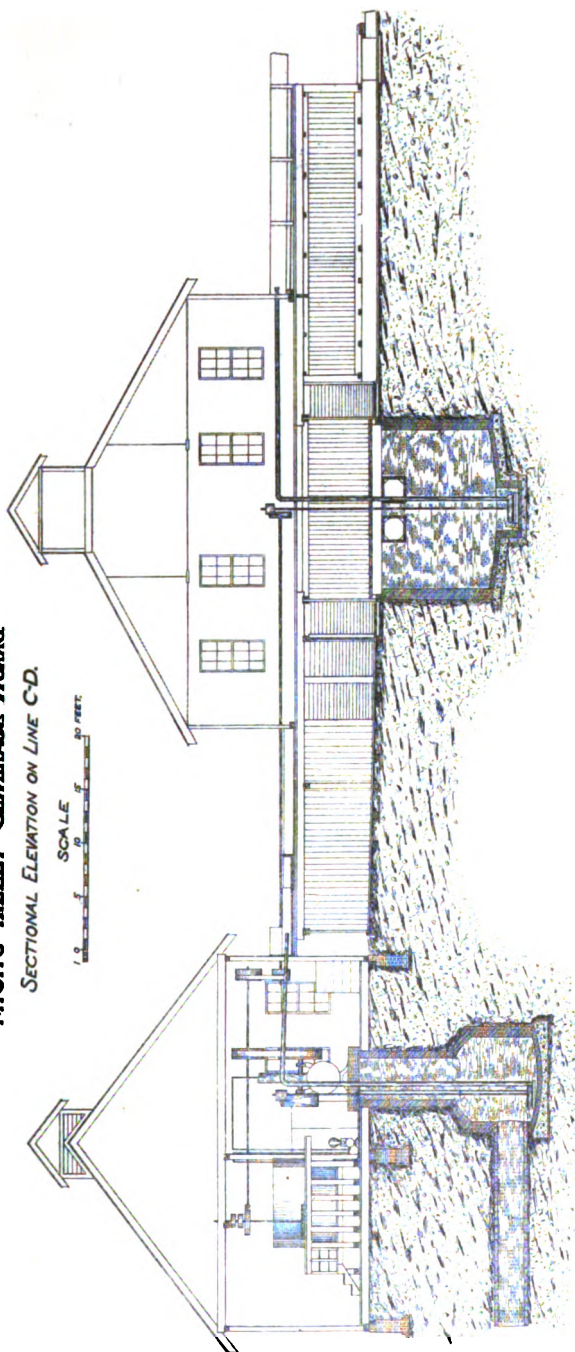
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**BOSTON WATER WORKS.**  
**MYSTIC VALLEY SEWERAGE WORKS**

SECTIONAL ELEVATION ON LINE C-D.







In the engine-house are three vats, so arranged that the precipitant is fed to the sewage from one vat placed lower and between the other two, in which the precipitant is dissolved; each vat is provided with a steam-pipe for heating the water used, and with an appliance for stirring, which is run from the engine.

After the precipitant is fed to the sewage, it is raised by pumping to the settling-tanks, where, after a tank is filled, it is allowed to settle for about three hours. The clarified liquid is then drawn off by means of narrow stop-planks, which are removed one by one. At this season of the year the tanks can be filled six times before it is necessary to remove the deposited sludge. This is removed through sluices which connect with a sludge-well placed in the middle space between the four tanks. From this sludge-well the sludge is pumped into a flume, by which it is carried to the settling-basins.

The average flow of the sewer is about 400,000 gallons in 24 hours, 75 per cent. of which is between 8 A.M. and 8 P.M. After 12 P.M. the flow from the sewer is practically clear water.

The results of several experiments show that 1 volume of sludge is deposited in the tanks to 30 volumes of sewage received. The sludge contains about 4 parts of dry solids to 96 parts of water; the water disappears in the settling-basins, and we have remaining a product sufficiently dry to be easily handled, and containing 4 parts of solids to 12 parts of water. On this basis the amount of "dry product" would be 10 cubic yards daily. The cost of the works, including the preparation of the settling-basins and incidentals, was \$10,410.18.

The accompanying plan and section shows the arrangement of the works.

#### MYSTIC CONDUIT AND RESERVOIR.

The conduit has been cleaned twice during the year, and is in good condition.

The eastern division of the reservoir was cleaned in 1884, and the other division should be cleaned out this year. The stone masonry of the western division has been repointed.

#### MYSTIC PUMPING-STATION.

The repairs to the roof of the pumping-station were completed early in the year. The flat roof of the coal bunker, which was badly decayed, has been replaced by a shed roof.

The four old boilers have about outlived their usefulness, and it would be economy to replace them with a new plant.

Engine No. 1 was in use 1,703 hours 55 minutes	pumping	279,978,500 gallons.
" " 2 " " 2,680 " 30 "	"	494,328,700 "
" " 3 " " 7,482 " 46 "	"	2,248,115,200 "
Total amount pumped		3,022,322,400 "

Total amount of coal consumed, 6,924,000 lbs.

Percentage ashes and clinkers, 8.4.

Average lift, in feet, 147.65.

Quantity pumped per pound of coal, 436.5 gallons.

Average duty of engines, no deductions, 53,750,600 ft. lbs. per 100 lbs. of coal.

Daily average amount pumped, 8,257,700 gallons, an increase of 8.2 per cent.

### *Cost of Pumping.*

Salaries	\$8,731 65
Fuel	13,684 02
Repairs	1,075 76
Oil, waste, and packing	790 59
Small supplies	102 73
Total	\$24,384 75

Cost per million gallons raised one foot high, 5.48 cents.

### DISTRIBUTION.

During the year the following changes have been made in the distribution system: —

Size of Pipe. "	SUDBURY-COCHITUATE WORKS.		MYSTIC WORKS.	
	Total Length laid and relaid.	Length of Pipe abandoned.	Length laid.	Length abandoned.
4	799	7,570	1,263	6,225
6	59,449	4,811	6,276	..
8	15,008	215	..	..
10	2,744	..	126	..
12	29,328	3,002	487	..
16	6,129	262	1,386	..
20	58	170	..	..
24	3,400	..	115	..
30	5,709	..	427	..
Total length	122,624	16,030	9,980	6,225

The total length of pipe laid on the Sudbury and Cochituate works was 23.22 miles, and 3.04 miles have been

abandoned, making a net increase of 20.18 miles in the total length in use. On the Mystic works the mains have been extended 9,980 feet, and 6,225 feet of 4-inch wrought-iron and cement pipe have been abandoned.

The 24-inch main to East Boston, the laying of which was commenced in 1887, has been completed between City square in Charlestown and Chelsea creek in Chelsea, and the new 30 and 16 inch mains have been laid with the exception of the portion on Warren bridge. The new 30-inch main has been connected with the old 20-inch pipe at each end of the bridge, and the pressure on the pipe in East Boston is increased 10 or 12 pounds. The 30-inch main starts from the 40-inch main on Boston Common opposite Mason street, and runs diagonally across the Common to the corner of Park and Beacon streets, thence through Beacon, Bowdoin, Allston, and Bulfinch streets, Bowdoin square, Chardon, Portland, Traverse, Haverhill, Causeway, and Beverly streets to Warren bridge, where it connects with the old 20-inch main. A connection has also been made with the old 24-inch main in Chardon street. These two connections with the new main have increased the head in the pipes at the north end of the city.

The 16-inch high-service main was laid from the corner of Mt. Vernon and Joy streets, through Joy, Myrtle, Derne, Bowdoin, and Cambridge streets to Chardon street, and from this point to Warren bridge the 16-inch and 30-inch pipes are laid in the same trench. On the Charlestown side the 30-inch and 16-inch pipes start near the crossing of the freight railroad on Warren avenue, and are laid in the same trench to City square, where the 30-inch is reduced to 24-inch, and connections are made with the 20-inch Cochituate and the 16-inch Mystic mains. The 24-inch and 16-inch pipes continue through Park street to Common street, where the pipes separate, the 16-inch running to Monument square, through Common and Winthrop streets, and the 24-inch through Common, Adams, and Chelsea streets to Chelsea bridge. The new 24-inch pipe was laid through the filled portion of Chelsea bridge, but the new 24-inch and the old 24-inch pipes are connected and carried over the bridge proper in one line of 30-inch pipe. In Chelsea the new 20-inch pipe was laid in Broadway, Williams, and Marginal streets, and is connected with the old 20-inch and 24-inch pipes crossing Chelsea creek to East Boston. When the 30-inch is laid across Warren bridge there will be two independent lines to East Boston, with the exception of the sections on Chelsea bridge.

A contract was made with the Gloucester Iron Works on

July 17, for furnishing 440 tons of 6-inch water-pipe for the supply of Long Island, and on August 3 a contract was made with Geo. W. Townsend for furnishing and laying a line of 6-inch pipe, with John F. Ward's flexible joints, between Moon and Long Islands. Each length of pipe between Moon and Long Islands was encased by four spruce planks, 11 feet 4 inches long and  $3\frac{1}{2}$  inches thick, and the space between the case and the pipe was filled with lime and cement grout, to protect the iron from the sewage that is discharged near that point. The pipe is placed below the surface of the bottom of the channel wherever there is less than 10 feet of water at mean low tide. The length of the line is 3,415 feet. The pipe was laid for a distance of 10,270 feet on Moon Island, and through Squantum. All further progress was delayed by complications with the town of Quincy. A contract was made with J. N. Hayes & Co. for building the siphon and pipe-box at Neponset bridge, for \$8,000; but the work was delayed for the same reason.

#### MISCELLANEOUS.

The pipe yard on Albany street has been enlarged by taking the adjoining wharf, formerly occupied by the City Hospital Department, and a sea wall, 168 feet in length, was built on the water front to replace the old wall, at a cost of \$5,965.90.

The following is a report from Mr. Desmond Fitz Gerald, Resident Engineer, of the work intrusted to his charge:—

BOSTON, Jan. 1, 1889.

WILLIAM JACKSON, ESQ., *Chief Engineer, Boston Water-Works*:—

SIR,—I submit herewith a brief report of the engineering work accomplished during the past year by the force on additional supply and improvement of the old sources.

Early in the year borings were begun at Basin 5 to ascertain the depth of the bed-rock below the surface of the valley, at the site of the dam. Two test-pits were partially sunk, but their indications were so different from the water-borings that it became evident that little reliance could be placed on the ordinary wash-out system. The ground is so full of large boulders that it will be necessary to use the diamond drill. On March 10 all work on the new basin was suspended, from lack of appropriations.

During the summer, surveys were made of the Course brook and Pegan meadows, at Lake Cochituate, and plans perfected for their improvement, by lowering the grade of the

bottom, and filling the shallow portions. On August 20 a contract was made by the Water Board with Auguste Saucier for the removal of 60,000 cubic yards of material at the Pegan meadows, and this work has just been satisfactorily completed.

Plans for new location of the highways on the site of Basin 5 have been made during the year, and have been accepted by the County Commissioners of Middlesex County.

Some experimental work on the subject of filtration has been prosecuted by the force under my direction, but the results are not sufficiently advanced to report upon at the present time.

Very truly yours,

DESMOND FITZ GERALD,  
*Resident Engineer.*

#### HIGH SERVICE.

The high-service district in the city proper is now supplied by a 24-inch pipe from Parker-Hill reservoir to Pynchon street, a distance of 2,900 feet; thence by a 20-inch pipe to Berkeley street, a distance of 4,520 feet, where the 12-inch pipe for the South Boston supply is taken off; thence by a 16-inch pipe to the 16-inch by 16-inch branch on Boston Common, a distance of 2,600 feet. During this season a large territory has been added to the high-service district in the city proper, and it is also proposed to make connection so that a portion of the Charlestown district can be supplied when the Mystic supply runs short. Estimating the maximum flow at present to be  $1\frac{1}{2}$  times the average consumption, there is a loss of head at the 16-inch by 16-inch branch of 25 feet, besides a sudden momentary additional loss of head of 30 feet, caused by the large draught of elevators. To remedy this excessive loss of head, it is necessary to provide an additional line of pipe from Parker-Hill reservoir. The additional line of pipe is also desirable in the contingency of an accident to the present line. I therefore recommend that a 20-inch main be laid from the present 24-inch pipe in Fisher avenue, at Parker Hill, to the 16-inch by 16 inch branch on the Common.

In the Roxbury and Dorchester high-service districts the present consumption is about 2,500,000 gallons daily, and in the higher portions of the districts the supply is at times unsatisfactory. To remedy the trouble now existing and to provide for the future wants of this growing district, it is necessary to lay a new main from the 16-inch pipe at the corner

of Parker and Centre streets, to the vicinity of Eggleston square, where, by being extended as necessity may require, it can be connected with the 12-inch pipes in Washington street and Walnut, Humboldt, Elm Hill, and Blue Hill avenues; also the 12-inch pipe in Seaver street should be connected from Walnut avenue to Maple street; and the connection between the 16-inch pipe in Centre street and the 24-inch pipe in Perkins street should be changed to 16-inch.

The sizes of pipes recommended above are based on the assumption that, when required, a main will be laid for the supply of Dorchester by way of Forest Hills and the proposed reservoir in West Roxbury.

#### ADDITIONAL SUPPLY.

The capacity of the combined Sudbury and Cochituate supplies, as at present developed, is 35,500,000 gallons daily for a dry year. The consumption for the past year was 33,310,700 gallons daily, an increase of 11.6 per cent. over the consumption of the previous year. Assuming that the increase for the next year will be equal to that of last year, the consumption will reach 37,174,700 gallons daily. That is, our consumption would be more than the dry years' capacity of our supply as at present developed. It is, therefore, evident that, for the protection of the city against a probable season of short supply of water, it is necessary to begin the further development of its resources at once.

After authority is obtained to proceed with the work of building an additional basin, several months will be required or necessary investigations and studies before the actual construction of a storage-basin can be proceeded with. The work of construction can, under the most favorable conditions, be completed in three working seasons; nearly one season will be required for the preliminary work, and the basin should be allowed to be filled one year before water is used from it; thus five years are required for the completion, ready for use, of a storage basin.

The figures below give the daily average rates of consumption for the past five years from the Sudbury and Cochituate works: —

1884	.	.	.	25,090,500	gallons.
1885	.	.	.	25,607,200	"
1886	.	.	.	26,627,900	"
1887	.	.	.	29,852,100	"
1888	.	.	.	33,310,700	"

The above shows an increase for the four years past of 32.8 per cent. Assuming the same rate of increased consumption, we should have in 1892 a daily average consumption of about 44,250,000 gallons. It is not believed, however, that the increase during this period will be at this rate; but a comparison of the rates of increase in the past five corresponding periods shows that it is reasonable to expect that the increase may not be less than 10 per cent. This percentage is based upon the assumption that it is safe to allow for a considerable reduction in the amount of water wasted, the waste of last year being largely increased by the long-continued cold weather during the early months. We may anticipate with reasonable certainty that in 1892 our water-works will be called upon to supply at least 36,750,000 gallons daily to the district now supplied by the Cochituate and Sudbury works; and should any additional territory now supplied from other sources be supplied from these works, this amount would be proportionately increased.

The capacity of the additional basin, for which the land has been partly acquired, is 4,500,000 gallons daily, and it will be seen, from the above, that even with the development of this basin, the works, with no allowance for possible additions to the territory now supplied, will have but a comparatively small surplus capacity.

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### C. — MAIN DRAINAGE WORKS.

The following is a statement of the condition of the appropriation for Improved Sewerage Construction, Jan. 1, 1889:—

Total appropriations . . . . .	\$5,412,994 93
Expended to Jan. 1, 1889. . . . .	5,400,795 29
	<hr/>
Balance . . . . .	\$12,199 64

The available balance is about \$6,000 less than the above, on account of amounts due under existing contracts.

The construction work for the past year was principally in Huntington avenue, where the location of the main sewer is crossed by the new channel for Stony Brook, at an expense of \$3,162.81; \$1,521.42 was paid on account of a judgment of the court in favor of Lucy Ellis, section 4, East side; \$1,660.15 was paid for the third edition of the "History of



Main Drainage;" \$768.50 was paid for a "sludge carrier," and the balance of the expenditure was on account of the work of the previous year.

The necessity for further extension of the main-sewer system is becoming more and more apparent, and the outlook is encouraging for the adoption in the near future of plans for the completion of the work now so successfully commenced by the present main-drainage system of Boston.

### SURVEY OF SEWERS.

An order was passed by the City Council, "That the Mayor be, and hereby is, requested to direct the Superintendent of Sewers, the City Engineer, and the City Surveyor to make a survey of all existing sewers, and to consider and report to the City Government the necessity of new sewers, and a systematic plan for their construction in the future;" and in compliance with the following order of the Mayor, dated Feb. 18, 1888, "In accordance with an order passed by the City Council and approved this date, you are hereby directed, in conjunction with the Superintendent of Sewers and City Surveyor, to make a survey of all existing sewers, and to consider and report to the City Government the necessity of new sewers, and a systematic plan for their construction in the future," a meeting of these officers was held at the office of the City Engineer, February 20, and it was voted to request the City Council for an appropriation of \$40,000, and the following communication was sent to His Honor the Mayor: —

OFFICE OF CITY ENGINEER,  
BOSTON, Feb. 20, 1888.

HON. HUGH O'BRIEN, *Mayor*.

*Dear Sir,* — In compliance with your communication of February 18, directing the Superintendent of Sewers, the City Engineer, and the City Surveyor "to make a survey of all existing sewers, and to consider and report to the City Government the necessity of new sewers, and a systematic plan of their construction in the future," we have this day organized and voted to request of the City Council an appropriation of \$40,000, for the purposes of making surveys and investigations for that object.

The necessity of doing this work is urgent, and it will be the means of saving a large expenditure to the city in the future.

Respectfully submitted,

(Signed)

SETH PERKINS, *Supt. of Sewers.*  
WILLIAM JACKSON, *City Engineer.*  
THOS. W. DAVIS, *City Surveyor.*

## D. — PARKS.

For the purpose of making this report a complete record of the work of this department the following statement, which was made to the Park Commissioners, and printed in their report to the City Council, is given : —

## THE PARKWAY. — BACK BAY FENS.

*Excavation of Waterway.* — In the spring, when the ice left the basin, the work of removing the earth dams across the channel at Agassiz Bridge and filling in the old channel across the Agassiz Road was begun. This was completed early in July.

During the remainder of the season, the dredger has been employed in completing portions of the channel which had previously been partially excavated, the completion of the new channel under Agassiz Bridge making it possible to empty the southerly part of the basin, thus discovering a number of places which were not down to grade, and also showing a considerable deposit from the overflow of Stony Brook. The dredging has been carried on at a considerable disadvantage, as a large part of the material had to be unloaded from the scows by wheelbarrows, all the places where it could be dumped directly from the scows having already been filled.

*Grading of Marsh.* — This work has been nearly completed, there being now about 19 acres of finished surface between grades 8 and 9, less than one acre remaining to be done.

*Drainage.* — Drains have been built in Charlesgate East, Charlesgate West, and Agassiz Road. The drains in Charlesgate East discharge into the common sewer, and other drains discharge as described in the report for 1887.

*Roadways, Walks, and Rides.* — April 9 a contract was made with the B. & A. R.R. Co. for delivering gravel. Most of this was used for completing the grading of Agassiz Road, and of Audabon Road from Agassiz Road to its junction with the Fenway, the balance being deposited on the southerly part of the Fenway. This work was completed August 9, and there were delivered 47,745 cubic yards of gravel, at \$0.57 per cubic yard.

On February 28 a contract was made with Albert A. and James O. Libby for furnishing curbstone for that portion of the Parkway between Beacon street and the Boston & Albany

Railroad. There were delivered 3,407  $\frac{7}{12}$  linear feet of curb-stone, at \$1.59 per linear foot.

A contract was made with John Shields for furnishing paving-blocks, under which he delivered 60,518 blocks, at \$44.37 per M.

The roadways and walks on the Parkway north of and including the Agassiz Road left incompleated last season have been graded and macadamized in the same manner as was described in the last annual report, the curbstones have been set and the gutters paved, so that this portion of the Parkway is entirely completed, excepting the planting of trees upon the borders of a portion of the drives, and the providing of some system of lighting.

In addition to the above, about 1,700 linear feet of Audubon Road southerly from Agassiz Road, has been sub-graded in readiness for setting the curbstone and macadamizing the roadway.

*Agassiz Bridge.* — This bridge, which was fully described in the last annual report, was completed in February with the exception of the parapet wall, which it is thought best to leave until the back-filling has settled.

*Grading of Slopes, Louming, and Planting.* — This work has been continued during the season, and there is a large area ready to be planted in the spring. The slopes between Agassiz and Audubon Roads and the basin, the large island in the southerly portion of the basin, and the mounds on the marsh near by, are ready for planting, and a large amount of grading has also been done on the slope between the Fenway and the basin.

On June 13 a contract was made with the Metropolitan Construction Company, under which they have deposited on the slopes of the Fenway 8,538 cubic yards of earth, at \$0.40 per cubic yard.

The Sewer Department has also deposited a large amount of earth excavated from the new channel of Stony Brook on the Fenway and adjoining slopes.

The following table, giving some of the items of work completed on the Parkway at Back Bay to date, may be of interest. A great deal of unfinished work which has been done on other portions of the Parkway, much of which is very near completion, is not contained in the table: —

		Percentage of whole amount to be done.
Channel excavated . . .	1,148,000 sq. ft.	82
Shore completed . . .	23,000 lin. ft.	90
Marsh " . . .	817,000 sq. ft.	95
Driveway completed . . .	41,000 sq. yds.	47
Walks " . . .	16,000 sq. yds.	30
Ride " . . .	3,000 sq. yds.	23
Curbing completed . . .	18,900 lin. ft.	50
Gutters " . . .	9,200 sq. yds.	45
Area covered with loam com- pleted . . .	701,000 sq. ft.	51
Area planted with loam com- pleted . . .	512,000 sq. ft.	37

In addition to the above, there have been built 4,663 linear feet of drains, 6 man-holes, and 55 catch-basins.

#### ARNOLD ARBORETUM.

The work of construction done during the past year has been confined to the planting of the slopes of the driveway to the top of Bussey Hill, where they are included within the city's reservation.

Some slight repairs have also been made on the drives and walks.

#### FRANKLIN PARK.

*Drives and Walks.* — The Glen, Pierpont, and Playstead Roads, together with a section of the Greeting to connect the two latter, and the entrances from Walnut avenue, have been completed.

The walks adjoining these roads have also been completed with the exception of a short length in the rear of the Shelter building. Glen Lane, for a length of about 2,400, and the circuit-drive in the Country Park, for a length of about 3,000 feet, have been graded.

On March 24 a contract was made with S. & R. J. Lombard for furnishing paving-blocks, and 111,106 blocks were delivered, at \$48 per M.

*The Overlook.* — The wall has been entirely completed and the face of it planted. Seats have been constructed of stone and covered with oak slats. The walk and the steps leading from the driveway have been finished, and four rustic drinking-fountains have been built of the stone found upon the park.

*The Shelter.* — This building is nearly completed, the excavation, the foundations, the masonry side-walls, the chimneys above the roof, and the outside steps having been

constructed by the park force, while the carpenter-work has been done by contract, under the direction of the City Architect. All the exposed masonry is of field stone, laid so as to show weather-worn and mossy-faces. The remainder of the building is covered with rived cypress shingles.

*Playstead Green.* — The grass-seed sown in the fall of 1887 has produced a fine turf, the care of which has required considerable labor, the grass having been kept cut short by means of lawn-mowers.

A flag-staff, consisting of a single stick 105 feet in length, has been erected. It stands upon a ledge, in about the centre of the green, and rests upon a cast-iron foot bolted to the ledge, the staff being supported laterally by three wire-rope guys attached to anchor-bolts set in the rock.

*Gateways.* — At the entrance to the Country Park, from the Playstead district, it is designed to have gates for closing this part of the park at night. Plans for these gateways were prepared by Messrs. Walker & Best, architects. There will be four wrought-iron gates, two for the driveway and one for each of the footpath entrances, which will run upon tracks laid across the driveway and walks. When the Country Park is open, these gates will be run into chambers of rustic masonry, which have been built for that purpose. Adjoining the gateway, about 230 feet of retaining-wall have been built on the line of Glen Lane.

*Ellicott Arch.* — The circuit drive will cross a footpath leading from the entrance at the junction of William street with Forest Hill street upon an arch of masonry. Work upon this arch was begun in midsummer, but was discontinued when the force was needed on other work.

The work has recently been resumed, and the arch will be completed early next season.

The following tables give some of the items of the work which has been completed to date. As is the case in the statement given in reference to the Parkway, a large amount of work has been done which cannot be stated in figures; such as clearing of grounds of trees and rocks, grading of grounds which have not as yet been finished, etc. :—

Driveways . . . . .	27,225 sq. yds.
Walks . . . . .	20,000 “
Gutters paved . . . . .	4,923 “
6-in. water-pipe laid . . . . .	3,000 lin. ft.
Hydrants . . . . .	3
Drinking-fountains . . . . .	4

2-ft. brick drain	.	.	.	.	519 lin. ft.
18-in. pipe	"	.	.	.	1,233 "
15-in. "	"	.	.	.	983 "
12-in. "	"	.	.	.	805 "
10-in. "	"	.	.	.	989 "
8-in. "	"	.	.	.	3,087 "
4-in. agricultural tile drain	.	.	.	.	900 "
3-in. "	"	"	"	.	1,200 "
2-in. "	"	"	"	.	9,500 "
					<hr/>
Total drains	.	.	.	.	19,140 lin. ft.
Man-holes	.	.	.	.	13
Catch-basins and inlets	.	.	.	.	50

The area of ground graded and planted or seeded, and not included in above table, is 34 acres.

#### MARINE PARK.

*Iron Pier.* — The building of the iron pier was suspended, on account of unfavorable weather, from January 15 to February 20, from which latter date the work was continued till November 7, when the work called for under the contract of July 11, 1887, was completed.

The connection between the temporary wooden pier and the iron pier was completed October 13, and the iron railings and lamp-posts were finished and in place December 8.

The completed portion of the iron pier was opened to the public on December 2.

The total length of the seventeen spans of pier now completed is 1,049.75 feet, and the four additional spans contracted for October 20 will increase the length to 1,296.75 feet.

*Curbstone.* — On April 18 a contract was made with the Lanesville Granite Company for furnishing an ornamental curb to be set on the line between the park and Q street. This contract was completed October 17, and there were furnished 1,390½ lin. ft. of curbstone at \$2.75 per foot. The stones have been set, and a small amount of grading done back of them.

In August a new and larger service-pipe was laid to connect the refectory building with the main water-pipe, the old pipe not having sufficient capacity to supply the increased demand for water due to the putting in of additional fixtures.

## WOOD ISLAND PARK.

The only work done upon this park during the year has been the construction of the iron bridge over the Boston, Revere Beach, & Lynn Railroad. This was completed, with the exception of the railing, on September 25, and the railing was completed in November. The approaches to the bridge have been graded.

## CHARLES RIVER EMBANKMENT.

In February the old buildings adjoining the West Boston Bridge were removed, and in April the Paving Department completed the removal of their buildings. The work of grading the park grounds has been completed, the areas for planting have been covered with loam and fertilized, and the drainage has been completed. An iron railing has been erected on the Embankment wall, with lamp-posts about 50 feet apart, and gas-pipes connecting with the mains of the Boston Gas Light Company have been laid to these lamp-posts. An iron fence has been erected around the gymnastic grounds at the northerly end of the Embankment, and these grounds have been prepared for their intended use with the exception of the erection of some apparatus.

The filling of the embankment has been extended under the West Boston Bridge by a sloping bank protected by rip-rap. This was done to prevent the thrust of the filling from moving the bridge. The gravel used was dredged from Charles river. The work was done by John T. Scully, at a cost of \$2,598.77, and was completed in October.

Gravel walks have been made wherever called for by the plans. It is not thought best to construct expensive walks at present, as the ground has been but recently filled, and is liable to considerable settlement.

The following table gives a statement of the work completed:—

Area of ground covered with loam in readiness for planting . . . . .	262,000 sq. ft.
Area of walks completed . . . . .	109,000 sq. ft.
Area of gymnastic ground . . . . .	65,000 sq. ft.
Drains laid . . . . .	1,220 lin. ft.
Man-holes built . . . . .	10
Catch-basins . . . . .	17
Iron railing on sea-wall . . . . .	2,250 lin. ft.
Lamp-posts “ “ . . . . .	52
Iron fence around gymnastic ground . . . . .	1,184 lin. ft.

**MUDDY RIVER AND STONY BROOK COVERED CHANNELS.**

Examinations have been made of these channels from time to time, and the portions of each where the foundation is in moving mud will have to be rebuilt or strengthened by inside bracing. A portion of the Muddy River conduit is temporarily strengthened, as described in last year's report.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in the Appendix. The openings have all been remeasured for this report.

WILLIAM JACKSON,  
*City Engineer.*



# CITY ENGINEERS.

1850-1888.

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E. S. CHESBROUGH, M. Am. Soc. C. E., Nov. 18, 1850, to Oct. 1, 1855.<sup>1</sup>

JAMES SLADE, Oct. 1, 1855, to April 1, 1863.<sup>2</sup>

N. HENRY CRAFTS, April 1, 1863, to Nov. 25, 1872.

JOSEPH P. DAVIS, M. Am. Soc. C. E., Nov. 25, 1872, to March 20, 1880.<sup>3</sup>

HENRY M. WIGHTMAN, M. Am. Soc. C. E., April 5, 1880, to April 3, 1885.<sup>4</sup>

WILLIAM JACKSON, M. Am. Soc. C. E., April 21, 1885, to present time.

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<sup>1</sup> Died August 18, 1886.

<sup>2</sup> Died August 25, 1882.

<sup>3</sup> Resigned March 20, 1880.

<sup>4</sup> Died April 5, 1885.

## APPENDICES.

## APPENDIX A.

*Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1889.*

NAME OF BRIDGES.	LOCATION.	NUMBER OF OPENINGS.	WIDTH.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown .	1	35	3
" "	Over Miller's River .	1	35	7
Broadway .	Over Fort-Point Channel .	1	43	3
Cambridge-st.	Ward 25 to Cambridge .	1	30	5
Canal .	Boston to East Cambridge .	1	35	10
Charles-river	Boston to Charlestown .	1	36	0
Chelsea (South Channel)	Charlestown to Chelsea .	1	38	8
" (North " )	" " .	1	44	6
Chelsea-st. (East Boston side)	East Boston to Chelsea .	2	33	4
" (Chelsea side)	" " .		34	3
Commercial-point	Ward 24 .	1	24	0
Congress-st. (Boston side)	Over Fort-Point Channel .	2	43	3
" (South Boston side)	" " .		43	11
Dover-st.	" " .	1	36	0
Eastern R.R.	Boston to Charlestown .	1	35	10
" "	Over Miller's River .	1	35	7
Essex-st.	Ward 25 to Cambridge .	1	30	11

Federal-st.	.	.	.	.	.	.	Over Fort-Point Channel	1	36	0
Fitchburg R.R.	.	.	.	.	.	.	Boston to Charlestown	1	35	9
" (for teaming freights)	.	.	.	.	.	.	" "	1	36	0
Grand Junction R.R.	.	.	.	.	.	.	Ward 25 to Cambridge	1	32	2
" "	.	.	.	.	.	.	East Boston to Chelsea	1	35	0
Granite	.	.	.	.	.	.	Ward 24 to Milton	1	30	11
Lowell R.R. (freight)	.	.	.	.	.	.	Boston to East Cambridge	1	35	8
" (passenger)	.	.	.	.	.	.	" "	1	35	10
Malden	.	.	.	.	.	.	Charlestown to Everett	1	43	4
Meridian-st. (East Boston side)	.	.	.	.	.	.	East Boston to Chelsea	2	59	0
" (Chelsea side)	.	.	.	.	.	.	" "	59	0	0
Mt. Washington-ave. (Boston side)	.	.	.	.	.	.	Over Fort-Point Channel	2	42	1
" (So. Boston side)	.	.	.	.	.	.	" "	42	4	4
Neponset	.	.	.	.	.	.	Ward 24 to Quincy	1	31	1
New York & New England R.R. (Boston side)	.	.	.	.	.	.	Over Fort-Point Channel	2	40	7
" "	.	.	.	.	.	.	" "	40	10	10
" "	.	.	.	.	.	.	Over South Bay	1	28	4
North Beacon-st.	.	.	.	.	.	.	Ward 25 to Watertown	1	30	2
North Harvard-st.	.	.	.	.	.	.	Ward 25 to Cambridge	1	31	8
Old Colony R.R.	.	.	.	.	.	.	Over Fort-Point Channel	1	36	0
" "	.	.	.	.	.	.	Ward 24 to Quincy	1	35	11
Prison-point	.	.	.	.	.	.	Charlestown to Cambridge	1	35	6
Warren	.	.	.	.	.	.	Boston to Charlestown	1	36	3
West Boston (Boston side)	.	.	.	.	.	.	Boston to Cambridge	2	35	8
" (Cambridge side)	.	.	.	.	.	.	" "	36	0	0
Western-ave.	.	.	.	.	.	.	Ward 25 to Cambridge	1	31	3
" "	.	.	.	.	.	.	Ward 25 to Watertown	1	30	0

## APPENDIX B.

**CITY ENGINEER'S REPORTS, 1868-1888.<sup>1</sup>**

Year.	Doc.	Year.	Doc.	Year.	Doc.
1868 .....	22	1877 .....	15	1883 .....	53
1869-70 .....	14	1878 .....	20	1884 .....	55
1871 .....	15	1879 .....	22	1885 .....	54
1872-73 .....	23	1880 .....	33	1886 .....	41
1874 .....	20	1881 .....	25	1887 .....	38
1875 .....	19	1882 .....	52	1888 .....	39, 117
1876 .....	24				

# CONTENTS CITY ENGINEER'S REPORTS, 1868-1888.

SUBJECT.	Year.	Doc.	Page.
<b>A</b> dams-street bridge (over O. C. R.R.)	1885	54	23
“ “ “ “	1886	41	20
“ “ “ “	1887	38	16
<b>A</b> dams-street survey	1868	22	29
<b>A</b> dditional water supply	1874	20	15
“ “ “	1875	19	13
“ “ “	1876	24	8
“ “ “	1877	15	37
“ “ “	1878	20	35
“ “ “	1879	22	34
“ “ “	1880	33	27
“ “ “	1881	25	27
<b>A</b> gassiz bridge (in B. B. Fens)	1888	39	38
“ “ “	1888	117	5
<b>A</b> lbany-street bridge (over B. & A. R.R.)	1868	22	21
“ “ “ “ “	1870	14	37
“ “ “ “ “	1871	15	69
“ “ “ “ “	1878	23	46
“ “ “ “ “	1874	20	35
“ “ “ “ “	1875	19	38
“ “ “ “ “	1876	24	33
“ “ “ “ “	1877	15	24
“ “ “ “ “	1878	20	26
“ “ “ “ “	1879	22	22
“ “ “ “ “	1880	33	17
“ “ “ “ “	1881	25	16
“ “ “ “ “	1882	52	19

<sup>1</sup> The dates given are for the year in which the document was published.

SUBJECT.	Year.	Doc.	Page.
Albany-street bridge (over B. & A. R.R.).....	1883	58	19
“ “ “ “ “ .....	1884	55	19
“ “ “ “ “ .....	1885	54	23
“ “ “ “ “ .....	1886	41	18
“ “ “ “ “ .....	1887	88	14
“ “ “ “ “ .....	1888	89	14
“ “ “ “ “ .....	1888	117	15
Albany-street bridge (over Roxbury canal).....	1870	14	29
“ “ “ “ “ .....	1871	15	54
“ “ “ “ “ .....	1873	23	38
“ “ “ “ “ .....	1874	20	21
“ “ “ “ “ .....	1875	19	19
“ “ “ “ “ .....	1876	24	12
“ “ “ “ “ .....	1877	15	8
“ “ “ “ “ .....	1878	20	8
“ “ “ “ “ .....	1879	22	7
Albany-street pipe-yard sea-wall.....	1888	89	24
Albany-street wall. ....	1868	22	12
Alford-street sea-wall.....	1881	25	17
“ “ .....	1882	52	20
Algae ..	1880	33	27
Army and navy monument .....	1875	19	48
Arnold Arboretum, P.....	1884	55	52
“ “ .....	1885	54	51
“ “ .....	1887	38	30
“ “ .....	1888	39	34
Artesian borings, M. D.....	1878	20	38
Ashland-street bridge (over B. & P. R.R.).....	1875	19	19
“ “ “ “ “ .....	1876	24	18
“ “ “ “ “ .....	1877	15	8
“ “ “ “ “ .....	1878	20	8
“ “ “ “ “ .....	1879	22	7
“ “ “ “ “ .....	1880	33	7
“ “ “ “ “ .....	1881	25	7
“ “ “ “ “ .....	1882	52	8
“ “ “ “ “ .....	1883	53	7, 19
“ “ “ “ “ .....	1884	55	7
“ “ “ “ “ .....	1885	54	8
“ “ “ “ “ .....	1886	41	9
“ “ “ “ “ .....	1887	38	6
“ “ “ “ “ .....	1888	39	5
“ “ “ “ “ .....	1888	117	6
Ashmont-street bridge (over O. C. R.R.).....	1884	55	20
Athens-street bridge (over N. Y. & N. E. R.R.).....	1875	19	20
“ “ “ “ “ .....	1876	24	18
“ “ “ “ “ .....	1877	15	8
“ “ “ “ “ .....	1878	20	8
“ “ “ “ “ .....	1879	22	7
“ “ “ “ “ .....	1880	33	7
“ “ “ “ “ .....	1881	25	7
“ “ “ “ “ .....	1882	52	8
“ “ “ “ “ .....	1883	53	8
“ “ “ “ “ .....	1884	55	7
“ “ “ “ “ .....	1885	54	8
“ “ “ “ “ .....	1886	41	9
“ “ “ “ “ .....	1887	38	7
“ “ “ “ “ .....	1888	39	6
“ “ “ “ “ .....	1888	117	5
Atlantic-avenue filling. ....	1871	15	42

SUBJECT.	Year.	Doc.	Page.
Atlantic-avenue retaining wall near Russia wharf.....	1875	19	41
“ soundings.....	1870	14	9
“ sea-wall.....	1871	15	41
“ sidewalk.....	1883	53	20
“ “.....	1885	54	24
“ survey.....	1870	14	9
<b>Back Bay:—</b>			
“ “ Bridges.....	1873	23	26
“ “ Fens.....	1888	39	31
“ “ filling.....	1882	52	43
“ “ “.....	1883	53	48
“ “ “.....	1884	55	48
“ “ “.....	1885	54	49
“ “ “.....	1886	41	46
“ “ improvement.....	1886	41	46
“ “ “.....	1887	38	30
“ “ park.....	1879	22	24
“ “ “.....	1885	54	49
<b>Basins, Water-Works:—</b>			
Nos. 2, 3, 4.....	1884	55	32
Basin No. 4.....	1885	54	34
Basin 1 dam.....	1879	22	35
“ 2 “.....	1880	33	29
“ 3 “.....	1880	33	30
“ 2 shallow flowage.....	1884	55	30
“ 3 “.....	1884	55	32
“ 3 “.....	1887	38	18
“ 4 “.....	1886	41	24
Beachmont avenue.....	1888	39	17
<b>Beacon-entrance bridge:—</b>			
(B. B. Fens, over B. & A. R.R.).....	1882	52	45
“ “ “ “.....	1883	53	8, 48
“ “ “ “.....	1884	55	7, 50
“ “ “ “.....	1885	54	8
“ “ “ “.....	1886	41	9
“ “ “ “.....	1887	38	7
“ “ “ “.....	1888	39	6
“ “ “ “.....	1888	117	6
Beacon-hill high-service W.W.....	1871	15	19
Beacon street.....	1883	53	25
“ “ raising grade.....	1887	38	16
“ “ “ pipe.....	1887	38	22
“ “ “.....	1888	39	24
Beacon street and Brookline avenue.....	1885	54	24
Beacon-street bridge (over B. & A. R.R.).....	1873	23	35
“ “ “ “.....	1885	54	3, 8
“ “ “ “.....	1886	41	9
“ “ “ “.....	1887	38	7
“ “ “ “.....	1888	39	7
“ “ “ “.....	1888	117	6
<b>Beacon-street bridge (over outlet of B. B. Fens pond; see, also, Mill-dam bridge)</b>			
“ “ “ “.....	1881	25	18
“ “ “ “.....	1882	52	8
“ “ “ “.....	1883	53	8
“ “ “ “.....	1884	55	8
“ “ “ “.....	1885	54	8
“ “ “ “.....	1886	41	9
“ “ “ “.....	1887	38	7

SUBJECT.	Year.	Doc.	Page.
Beacon-street bridge (over outlet of B. B. Fens pond; <i>see, also, Mill-dam bridge</i> )	1888	39	6
“ “ “ “ “ “	1888	117	6
Beacon-street widening . . . . .	1880	33	21
“ “ “ “ “ “	1881	25	19
Beacon-street and Commonwealth avenue bridges . . . . .	1882	52	45
Beech-street bridge (over B. & P. R.R.) . . . . .	1878	20	27
“ “ “ “ “ “	1883	53	19
“ “ “ “ “ “	1884	55	20
“ “ “ “ “ “	1885	54	23
“ “ “ “ “ “	1886	41	20
“ “ “ “ “ “	1887	38	15
“ “ “ “ “ “	1888	39	15
Bellevue-avenue bridge (over B. & P. R.R.) . . . . .	1887	38	15
“ “ “ “ “ “	1888	39	15
Bennington-street extension . . . . .	1887	38	16
Berkeley-street bridge (over B. & A. R.R.) . . . . .	1868	22	23
“ “ “ “ “ “	1870	14	38
“ “ “ “ “ “	1871	15	69
“ “ “ “ “ “	1873	23	47
“ “ “ “ “ “	1874	20	22
“ “ “ “ “ “	1875	19	21
“ “ “ “ “ “	1876	24	14
“ “ “ “ “ “	1877	15	8
“ “ “ “ “ “	1878	20	8
“ “ “ “ “ “	1879	22	8
“ “ “ “ “ “	1880	33	7
“ “ “ “ “ “	1881	25	7
“ “ “ “ “ “	1882	52	10
“ “ “ “ “ “	1883	53	8
“ “ “ “ “ “	1884	55	8
“ “ “ “ “ “	1885	54	8
“ “ “ “ “ “	1886	41	9
“ “ “ “ “ “	1887	38	7
“ “ “ “ “ “	1888	39	7
“ “ “ “ “ “	1888	117	6
Berkeley-street bridge (over B. & P. R.R.) . . . . .	1870	14	39
“ “ “ “ “ “	1871	15	70
“ “ “ “ “ “	1873	23	47
“ “ “ “ “ “	1874	20	22
“ “ “ “ “ “	1875	19	21
“ “ “ “ “ “	1876	24	14
“ “ “ “ “ “	1877	15	8
“ “ “ “ “ “	1878	20	9
“ “ “ “ “ “	1879	22	8
“ “ “ “ “ “	1880	33	7
“ “ “ “ “ “	1881	25	8
“ “ “ “ “ “	1882	52	10
“ “ “ “ “ “	1883	53	8
“ “ “ “ “ “	1884	55	8
“ “ “ “ “ “	1885	54	9
“ “ “ “ “ “	1886	41	10
“ “ “ “ “ “	1887	38	7
“ “ “ “ “ “	1888	39	7
“ “ “ “ “ “	1888	117	6
Berkeley-street retaining-walls . . . . .	1871	15	49
“ “ “ “ “ “	1874	20	87
“ “ “ “ “ “	1877	15	26
Berwick-park retaining-wall . . . . .	1876	24	35



SUBJECT.	Year.	Doc.	Page.
Blakemore-street bridge (over B. & P. R.R.) .....	1881	25	22
"    "    "    "    "    " .....	1882	52	10, 20
"    "    "    "    "    " .....	1883	53	9
"    "    "    "    "    " .....	1884	55	8
"    "    "    "    "    " .....	1885	54	9
"    "    "    "    "    " .....	1886	41	10
"    "    "    "    "    " .....	1887	38	7
"    "    "    "    "    " .....	1888	39	7
"    "    "    "    "    " .....	1888	117	6
B. & A. R.R. bridge (over Park water-way) .....	1882	52	45
"    "    "    "    "    " .....	1883	53	49
Boilers, Chestnut-hill pumping-station .....	1888	39	17
Highland .....	1878	20	31
Mystic .....	1884	55	34
Boylston-street arch bridge .....	1881	25	41
"    "    "    "    "    " .....	1882	52	44
"    "    "    "    "    " .....	1883	53	49
"    "    "    "    "    " .....	1884	55	8, 50
"    "    "    "    "    " .....	1885	54	9, 50
"    "    "    "    "    " .....	1886	41	10
"    "    "    "    "    " .....	1887	38	7
"    "    "    "    "    " .....	1888	39	7
"    "    "    "    "    " .....	1888	117	6
Boylston-street bridge (over B. & A. R.R.) .....	1885	54	50
"    "    "    "    "    " .....	1887	38	16
"    "    "    "    "    " .....	1888	39	16
"    "    "    "    "    " .....	1888	117	7
Boylston-street extension .....	1876	24	33
Bridges .....	1868	22	15
"    "    "    "    "    " .....	1870	14	27
"    "    "    "    "    " .....	1871	15	53
"    "    "    "    "    " .....	1873	23	8, 36
"    "    "    "    "    " .....	1874	20	17
"    "    "    "    "    " .....	1875	19	15
"    "    "    "    "    " .....	1876	24	9
"    "    "    "    "    " .....	1877	15	3
"    "    "    "    "    " .....	1878	20	3
"    "    "    "    "    " .....	1879	22	3
"    "    "    "    "    " .....	1880	33	3
"    "    "    "    "    " .....	1881	25	3
"    "    "    "    "    " .....	1882	52	8, 44
"    "    "    "    "    " .....	1883	53	3
"    "    "    "    "    " .....	1884	55	3
"    "    "    "    "    " .....	1885	54	3
"    "    "    "    "    " .....	1886	41	3
"    "    "    "    "    " .....	1887	38	3
"    "    "    "    "    " .....	1888	39	3
"    "    "    "    "    " .....	1888	117	2
Bridges supported by railroad corporations .....	1874	20	37
"    "    "    "    "    " .....	1875	19	38
"    "    "    "    "    " .....	1876	24	32
"    "    "    "    "    " .....	1877	15	25
"    "    "    "    "    " .....	1878	20	27
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“ “ “ “ “ .....	1885	54	11
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“ “ “ “ .....	1882	52	18
“ “ “ “ .....	1883	53	18
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“ “ “ “ .....	1885	54	22
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“ “ “ “ .....	1880	33	16
“ “ “ “ .....	1881	25	16
“ “ “ “ .....	1882	52	18
“ “ “ “ .....	1883	53	18
“ “ “ “ .....	1884	55	18
“ “ “ “ .....	1885	54	22
“ “ “ “ .....	1886	41	18
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" " " " " " " " " " " "	1883	53	19
" " " " " " " " " " " "	1884	55	19
" " " " " " " " " " " "	1885	54	22
" " " " " " " " " " " "	1886	41	19
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“ “ “ .....	1875	19	33
“ “ “ .....	1876	24	30
“ “ “ .....	1877	15	21
“ “ “ .....	1878	20	20
“ “ “ .....	1879	22	19
“ “ “ .....	1880	33	12
“ “ “ .....	1881	23	21
“ “ “ .....	1882	52	16
“ “ “ .....	1883	53	15
“ “ “ .....	1884	55	15
“ “ “ .....	1885	54	19
“ “ “ .....	1886	41	16
“ “ “ .....	1887	38	11
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Boston.

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**TWENTY-THIRD ANNUAL REPORT**

OF THE

**CITY ENGINEER,**

FOR THE

**YEAR 1889.**



**BOSTON:  
ROCKWELL AND CHURCHILL, CITY PRINTERS.  
1890.**



# TWENTY-THIRD ANNUAL REPORT

OF THE

## CITY ENGINEER,

FOR THE

1889.

*With Compliments of*

*William Jackson,*

*City Engineer.*

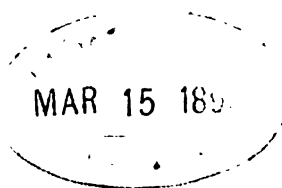


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Wm. Jackson,  
City Eng.

[DOCUMENT 39 — 1890.]

CITY OF



BOSTON.

## TWENTY-THIRD ANNUAL REPORT

OF THE

# CITY ENGINEER,

FOR THE YEAR 1889.

OFFICE OF THE CITY ENGINEER, CITY HALL,  
BOSTON, Jan. 15, 1890.

*To the Honorable City Council: —*

In compliance with the seventh section of the ordinance relating to the Engineer's Department, the following report of the expenses and operations of the department for the year 1889 is respectfully submitted: —

The duties of the City Engineer may be classified under the following heads: —

A. — Those pertaining to the City Engineer's Department proper, which consist in examination and supervision of structural repairs of bridges; in designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council. (City Engineer's Department.)

B. — Superintendence of the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works. (Water-Works.)

C. — Charge of the construction of a system of intercepting and outlet sewers. (Improved Sewerage, or Main Drainage.)

D. — Charge of the engineering work in connection with the Back-Bay and other proposed parks. (Parks.)

The expenses incurred under the head C are paid wholly from a special appropriation.

#### A. — CITY ENGINEER'S DEPARTMENT.

The following is a statement of engineering expenses from January 1, 1889, to January 1, 1890 :—

Amount expended from department appropriation for 1888-89 . . . . .	\$10,203 64
Amount expended from department appropriation for 1889-90 . . . . .	25,407 22
<b>Total . . . . .</b>	<b>\$35,610 86</b>

Condition of department appropriation :—

Amount of appropriation for financial year 1889-90 . . . . .	\$35,000 00
Amount expended to January 1, 1890 . . . . .	25,407 22
<b>Unexpended balance, January 1, 1890 . . . . .</b>	<b>\$9,592 78</b>

#### CLASSIFICATION OF EXPENSES.

Salaries of City Engineer, assistants, draughtsmen, transitmen, levellers, rodmen, etc. . . . .	\$32,152 12
Engineering instruments and repairs of same . . . . .	478 15
Drawing-paper, and all materials for making plans . . . . .	327 35
Stationery, printing-stock, note-books, postage, etc. . . . .	293 56
Reference library, binding books, and photographs of works . . . . .	622 59
Printing . . . . .	193 60
Travelling expenses (including horse-keeping, repairs on vehicle, etc.) . . . . .	587 64
Telephone service . . . . .	126 00
Furniture cases for plans and books, etc. . . . .	419 00
Blue-process printing . . . . .	118 48
Incidental expenses, and all other small supplies . . . . .	292 37
<b>Total . . . . .</b>	<b>\$35,610 86</b>

The number of persons employed and paid from the department appropriation was, on the 1st of January, 1889, 21; the present number (including the City Engineer) is 20.

The operations of the department for the year, together with such general information relating to the various works and structures, finished and in progress, as is thought to be of interest, are given in the following statements : —

### BRIDGES.

In accordance with Section 5, Chapter 18, of the Revised Ordinances, the estimates of cost of repairs submitted by the Superintendent of Bridges has been revised and reported upon, and structural repairs required have been ordered and supervised.

As required by Section 4 of the above, examinations have been made of all highway bridges within the city limits, and the usual routine work of superintending the repairs made by the Bridge Department upon those in its charge has been done.

#### LIST OF BRIDGES INSPECTED.

Five bridges have been added to the list this year, namely : —

Bolton-street Bridge, over N. Y. & N. E. Railroad ; Byron-street Bridge, over Boston, Revere Beach, & Lynn Railroad ; Cottage-street Foot-bridge, over flats, East Boston ; Leyden-street Bridge, over Boston, Revere Beach, & Lynn Railroad on Breed's Island ; and Harvard Bridge, over Charles river.

In the list, those signed with an asterisk are over navigable waters, and are each provided with a draw.

#### I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Agassiz road, in Back Bay Fens.

Ashland street, Ward 23, over Boston & Providence Railroad.

Athens street, over New York & New England Railroad.

Beacon Entrance, Back Bay Fens, over Boston & Albany Railroad.

Beacon street, over outlet to Back Bay Fens.

Beacon street, over Boston & Albany Railroad.

Berkeley street, over Boston & Albany Railroad.

Berkeley street, over Boston & Providence Railroad.

Blakemore street, over Boston & Providence Railroad, Ward 23.

Bolton street, over New York & New England Railroad.

Boylston street, in Back Bay Fens.

Boylston street, over Boston & Albany Railroad.

\*Broadway, over Fort Point Channel.

Broadway, over Boston & Albany Railroad.  
Brookline avenue, over Boston & Albany Railroad.  
Byron street, over Boston, Revere Beach, & Lynn Railroad.

\*Charles river, from Boston to Charlestown.  
\*Chelsea (south), over South Channel, Mystic river.  
\*Chelsea street, from East Boston to Chelsea.  
Columbus avenue, over Boston & Albany Railroad.  
\*Commercial point, or Tenean, Ward 24.  
Commonwealth avenue, in Back Bay Fens.  
\*Congress street, over Fort Point Channel.  
Cottage-street foot-bridge, over Flats, East Boston.  
Dartmouth street, over Boston & Albany and Boston & Providence Railroads.

\*Dover street, over Fort Point Channel.  
\*Federal street, over Fort Point Channel.  
Ferdinand street, over Boston & Albany Railroad.  
Franklin-street foot-bridge, over Boston & Albany Railroad.  
Huntington avenue, over Boston & Albany Railroad.  
Leyden street, over Boston, Revere Beach, & Lynn Railroad.

Linden Park street, over Stony brook.  
\*Malden, from Charlestown to Everett.  
\*Meridian street, from East Boston to Chelsea.  
\*Mt. Washington avenue, over Fort Point Channel.  
Neptune road, over Boston, Revere Beach, & Lynn Railroad.

Newton street, over Boston & Providence Railroad.  
Public Garden foot-bridge.  
Shawmut avenue, over Boston & Albany Railroad.  
Swett street, east of New York & New England Railroad.  
Swett street, west of New York & New England Railroad.  
\*Warren, from Boston to Charlestown.  
West Chester Park, over Boston & Albany Railroad.  
West Chester Park, over Boston & Providence Railroad.  
West Rutland square foot-bridge, over Boston & Providence Railroad.

Winthrop, from Breed's Island to Winthrop.

## II. -- BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

\*Cambridge street, from Brighton to Cambridge.  
Central avenue, from Ward 24 to Milton.  
\*Chelsea (north), from Charlestown to Chelsea.  
\*Essex street, from Ward 25 (Brookline) to Cambridge.  
\*Granite, from Dorchester, Ward 24, to Milton.

Longwood avenue, from Ward 22 to Brookline.  
Mattapan, from Ward 24 to Milton.  
Milton, from Ward 24 to Milton.  
\*Neponset, from Ward 24 to Quincy.  
\*North Beacon street, from Brighton to Watertown.  
\*North Harvard street, from Brighton to Cambridge.  
Spring street, from West Roxbury to Dedham.  
\*Western avenue, from Brighton to Cambridge.  
\*Western avenue, from Brighton to Watertown.

### III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

Albany street, over Boston & Albany Railroad.  
\*Canal, from Boston to Cambridge.  
Dorchester street, over Old Colony Railroad.  
\*Harvard, from Boston to Cambridge.  
\*Prison Point, from Charlestown to Cambridge.  
\*West Boston, from Boston to Cambridge.

### IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

#### *1st. — Boston & Albany Railroad.*

Commonwealth avenue, Brighton.  
Harrison avenue.  
Market street, Brighton.  
Tremont street.  
Washington street.

#### *2d. — Boston & Maine Railroad, Western Division.*

Mystic avenue.  
Main street.

#### *3d. — Boston & Maine Railroad, Eastern Division.*

Mystic avenue.  
Main street.

#### *4th. — Boston, Revere Beach, & Lynn Railroad.*

Everett street.

#### *5th. — New York & New England Railroad.*

Broadway.  
Dorchester avenue.  
Fifth street.  
Forest Hills avenue, Ward 24.

Fourth street.  
 Harvard street, Ward 24.  
 Norfolk " " "  
 Norfolk " " "  
 Second street.  
 Silver street.  
 Sixth street.  
 Third street.  
 Washington street, Ward 24.

*6th. — Old Colony Railroad.*

Adams street.  
 Ashmont street and Dorchester avenue.  
 Cedar Grove Cemetery.  
 Commercial street.  
 Savin Hill avenue.

*7th. — Old Colony Railroad, Providence Division.*

Beech street, Ward 23.  
 Bellevue street, Ward 23.  
 Canterbury street, Ward 23.  
 Centre street, or Hog Bridge, Ward 23.  
 Centre and Mt. Vernon streets, Ward 23.  
 Dudley avenue, Ward 23.  
 Park street, Ward 23

RECAPITULATION.

I.	Number wholly supported by Boston . . . . .	46
II.	Number of which Boston supports the part within its limits . . . . .	14
III.	Number of which Boston pays a part of the cost of maintenance . . . . .	6
IV.	Number supported by railroad corporations: —	
1.	Boston & Albany . . . . .	5
2.	Boston & Maine, Western Division . . . . .	2
3.	" " Eastern Division . . . . .	2
4.	Boston, Revere Beach, & Lynn . . . . .	1
5.	New York & New England . . . . .	13
6.	Old Colony . . . . .	5
7.	" " Providence Division . . . . .	7
	Total number . . . . .	101

## I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

## AGASSIZ-ROAD BRIDGE IN BACK BAY FENS.

This is a new bridge, built in 1887, of brick and stone masonry, and was opened to the public on Oct. 2, 1888. It is maintained by the Park Department, and is in good condition.

## ASHLAND-STREET BRIDGE (OVER BOSTON &amp; PROVIDENCE RAILROAD, WARD 23).

The present structure is of iron, and was built in 1875. The iron-work and fences should be painted; otherwise it is in good condition.

## ATHENS-STREET BRIDGE (OVER NEW YORK &amp; NEW ENGLAND RAILROAD).

This is an iron bridge, and was built in 1874.

It is very rusty; it should be stripped, painted, and wood-work renewed.

## BEACON-ENTRANCE BRIDGE (IN BACK BAY FENS, OVER BOSTON &amp; ALBANY RAILROAD).

This is an iron bridge, and was built in 1881-82.

It is maintained by the Park Department, and is in good condition. It has been painted.

## BEACON-STREET BRIDGE (OVER OUTLET OF BACK BAY).

This is an iron bridge, built in 1880-81, and is in good condition.

## BEACON-STREET BRIDGE (OVER BOSTON &amp; ALBANY RAILROAD).

This is an iron bridge; it was built in 1884-85, and was widened in 1887-88.

It has been painted, and is in good condition.

## BERKELEY-STREET BRIDGE (OVER BOSTON &amp; ALBANY RAILROAD).

This is an iron bridge. It was built by the Boston Water Power Company, and was accepted by the city in 1869.

Slight repairs have been made, but the bridge is on an



important cross street and is not fit for its place. Its construction is too light, and it should be rebuilt with new abutments.

**BERKELEY-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge. It was built by the Boston Water Power Company, and was accepted by the city in 1869.

It has been sheathed and other slight repairs made. It is in fair condition.

**BLAKEMORE-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge. It was built in 1881-82.

It has been sheathed and painted, and the fences have been repaired. It is in good condition.

**BOLTON-STREET BRIDGE (OVER NEW YORK & NEW ENGLAND RAILROAD).**

This is a new wooden bridge. (See page 22.)

**BOYLSTON-STREET BRIDGE (IN BACK BAY FENS).**

This is a stone masonry bridge, and it was built in 1881-83.

It is maintained by the Park Department, and is in good condition.

**BOYLSTON-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and it was built in 1886-88.

The iron-work above the floor has been painted. One of the truss-bars has been injured by being run into by an electric car. The iron-work under the floor should be painted at once. Painting this bridge above the floor cost \$620.69, and it will cost as much or more to paint the work below the floor.

**\* BROADWAY BRIDGE (OVER FORT POINT CHANNEL).**

This is an iron bridge. It was built in 1869-71, and the draw and its foundation were rebuilt in 1874-75.

The entire face of the draw-pier will soon need to be renewed. During the past year it was repaired above low tide level. The two 100-ft. spans and the two 50-ft. spans of

this bridge are of light construction and show great vibration with quick-moving loads, but the steep grades at the ends save the bridge from the heaviest class of teaming.

The tar concrete sidewalks on the fixed part of the bridge need repairs; the spruce floor underneath has been laid twenty years, but it is apparently in good condition, excepting at the edges and joints.

Of the three varieties of asphaltic roadway pavement laid for experimental purposes last year, two have been taken away; the third has been repaired and is still in use, although it is in an imperfect condition. That part of the bridge from Lehigh street to the O. C. R.R. has been painted.

#### **BROADWAY BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, was built in 1880-81, and is in good condition.

The iron-work is very rusty under the floor, notwithstanding it was stripped and painted two years ago, and the fences and all of the iron-work above the deck need painting.

#### **BROOKLINE-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, and was built in 1884. It is in good condition.

#### **BYRON-STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD).**

This is a new wooden bridge. (See page 22.)

#### **\* CHARLES-RIVER BRIDGE (FROM BOSTON TO CHARLESTOWN.)**

This is a wooden pile bridge with an iron draw. The original bridge was built in 1785-86, the present structure was built in 1854-55, and the draw was built in 1870. It is an old bridge, and is in poor condition. The paving is very poor, and from the construction of the bridge it cannot be maintained in good condition for any length of time. The best modern pavements are constructed with a substratum of cement concrete from six to eight inches thick, while this bridge and other similar bridges have for a substratum a layer of marsh mud one foot in thickness. The bridge is heavily loaded with mud, gravel, and paving, and it also has a tendency to sag towards the east; this motion has increased

recently, and it will be necessary to cross-brace the bents of piles for a considerable portion of the bridge in order to keep it in place.

The draw continues to work in a fairly satisfactory manner, the southerly draw-pier needs replanking, and the floor-timbers of the draw should be repaired next season.

**\* CHELSEA BRIDGE, SOUTH (OVER SOUTH CHANNEL, MYSTIC RIVER).**

This is a pile bridge with an iron draw. The original bridge was built in 1802-3, and the present structure in 1876-77.

A new under-floor of kyanized spruce has been laid on the greater part of the draw, and some smaller repairs made. The easterly draw-pier needs replanking; otherwise the bridge is in good condition.

**\* CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

This wooden pile bridge was originally built in 1834, and was rebuilt in 1848; the present structure was built in 1873, and the draw was built in 1868.

This bridge is in bad condition and should be rebuilt. The *limnoria*, or small pile-worm, is quite active in this vicinity, and the draw foundation has been nearly destroyed by it. The draw itself is a narrow wooden structure (22 feet wide). It was built in 1868, and has been patched so much that if it is to be kept in use it will be necessary to take it about all down in order to renew the defective portions. A wooden draw of this class remains in good condition for about fifteen years, and after that time can be maintained only by expensive repairs. The part of the bridge between the draw and Chelsea was burned in 1887, and rebuilt in a temporary manner, and the draw is so low that it will be necessary to raise the grade of the whole bridge when a new draw is built.

**COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, was originally built in 1865, and the present structure was built in 1876-77. The under-floor of the roadway is not in good condition, and the bridge should be stripped of wood-work, the iron-work cleaned, carefully examined, and painted; new sidewalks should also be laid.

The telegraph-pole guys remain attached to the bridge, as before reported. They should be removed.

**\*COMMERCIAL-POINT, OR TENEAN, BRIDGE (WARD 24).**

This is a wooden pile bridge with a wooden leaf draw. It was originally built in 1833, and the present structure was built in 1875. It is in fair condition.

**COMMONWEALTH-AVENUE BRIDGE (IN BACK BAY FENS).**

This is an iron bridge, and it was built in 1881-82. It is in good condition.

**\*CONGRESS-STREET BRIDGE (OVER FORT POINT CHANNEL).**

This is a wooden pile bridge with an iron turn-table draw on a stone masonry foundation. It was built in 1874-75.

On October 9 the draw was temporarily disabled by the breaking of a 3-inch bolt, one of eight by which the draw is suspended. The broken bolt caused other damage, which was so serious as to require the draw to be thrown out of use for two days, during which time repairs were made.

The machinery for moving the draw requires repairs; the fender-guards are in bad condition, and the floor of the fixed part of the bridge will require patching.

No repairs of importance have been made during the season excepting those caused by the broken bolt, before mentioned.

**COTTAGE-STREET FOOT-BRIDGE (OVER FLATS, EAST BOSTON).**

This is a new wooden pile bridge. (See page 23.)

**DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND BOSTON & PROVIDENCE RAILROADS).**

This is an iron bridge; it was originally built in 1869, and the present structure was built in 1878-79.

It has been repaired by laying a new under-floor of kyanized spruce 4 inches thick, and by painting the iron stringers under the roadway. It is in good condition.

**\*DOVER-STREET BRIDGE (OVER FORT POINT CHANNEL).**

This is a wooden pile bridge with a double iron draw; it was originally built in 1805, was rebuilt in 1858-59, and the present structure was built in 1876.

The work upon the sides of the water-way, begun in 1888, has not been completed. It should be done at once. The sidewalks are in poor condition, and the draws require new under-floors, and some work must be done to the floor of the fixed part of the bridge. The draws have been painted. Only ordinary repairs have been made.

**\*FEDERAL-STREET BRIDGE (OVER FORT POINT CHANNEL).**

This is a wooden pile bridge with a double wooden draw ; it was originally built in 1827-28 ; was rebuilt in 1857-58, and the present structure was built in 1872-73.

This bridge is in bad condition. A special report was made in 1888 (Appendix B, Doc. 117, 1888), and the recommendation then made that it be rebuilt. Extensive repairs were made to the draws this year, throwing them out of use (one at a time) for a considerable time, and causing much complaint. It will soon be necessary to make even more extensive repairs if the bridge is not rebuilt, and it may even be found necessary to close it to travel. Practically, the bridge must either be rebuilt, or it should be closed to travel.

**FERDINAND-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1864-65, and was strengthened in 1877.

It has two iron trusses of an unusual construction. They are weak, and the bridge was strengthened by adding to it an iron truss removed from the Columbus-avenue bridge, when that was rebuilt. The additional truss was placed in the middle of the roadway, dividing it into two narrow passages. The floor-beams are light 6-inch iron I beams encased in wood, and have never been uncovered for examination. The sidewalk trusses are of wood, and in fair condition.

The northerly approach to the bridge has two deck spans carried on iron posts, and rolled I beams braced with wood. There is a wooden bulkhead across the street, and the side of the street for some distance is supported by a continuation of this bulkhead.

The bridge is in a dangerous condition, and it should be rebuilt.

**FRANKLIN-STREET FOOT-BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1883. It has been painted; the wooden steps are worn, and will soon need renewal; otherwise it is in good condition.

**HUNTINGTON-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1872, and the abutments were rebuilt in 1876-77.

The roadways have been sheathed. The water-pipes have been laid under the sidewalk and between the iron girders, instead of on the top of the sidewalk, as before. The bridge is in good condition.

**LEYDEN-STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD).**

This is a new iron bridge. (See page 23.)

**LINDEN PARK-STREET BRIDGE (OVER STONY BROOK).**

This is a wooden truss bridge, built in 1886. It has been sheathed and painted, and is in good condition.

**\*MALDEN BRIDGE (FROM CHARLESTOWN TO EVERETT).**

The original bridge was built in 1787. The present structure was built in 1875, and the draw was built in 1872. It is a pile bridge with a wooden turn-table draw on a pile foundation. The draw has been repaired and put in safe condition; the draw and fences have been painted. The draw is so old that it can be kept in use but a short time longer. The draw-piers are also old, but are in fair condition. The fixed part of the bridge is in fair condition.

**\*MERIDIAN-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

This is a wooden pile bridge with a wooden turn-table draw on a pile foundation. The original structure was built in 1856. It was rebuilt soon afterwards; it was widened and rebuilt as at present in 1884, excepting the draw, which was built in 1875-76.

A new upper and under track and new wheels have been furnished for the draw, and a number of the angle-blocks

renewed in the main trusses. The draw is old, and will require further repairs during the coming year. The fixed part of the bridge is in good condition.

**\*MT. WASHINGTON-AVENUE BRIDGE (OVER FORT POINT CHANNEL).**

This is a wooden pile bridge with an iron draw. It was built in 1854, and was rebuilt in 1870-71.

The draw has been painted. The sidewalks on the fixed part of the bridge are in poor condition. The draw needs raising on its centre in order to relieve the wheels from excessive weight. With these exceptions the bridge is in good condition.

**NEPTUNE-ROAD BRIDGE (OVER REVERE BEACH & LYNN RAILROAD IN EAST BOSTON).**

This is an iron bridge, and it was built in 1887-88.

It is maintained by the Park Department, and is in good condition.

**NEWTON-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge, and was built in 1872.

It is in fair condition. It should be stripped of wood-work, so as to allow of a careful examination of the iron-work. The under-floor was laid in 1878.

**PUBLIC GARDEN FOOT-BRIDGE.**

This is an iron bridge. It was built in 1867, and was thoroughly repaired in 1887.

It is in good condition.

**SHAWMUT-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and it was built in 1871.

This bridge has been stripped of wood-work, with the exception of the westerly sidewalk, which was nearly all renewed in 1888. The iron-work was cleaned and painted. The span over the main tracks is considerably wasted by corrosion; some of the cross-braces, which are the smallest of the pieces of iron exposed on all sides, are entirely gone, but enough of them remain for safety. This span is safe for the present, and may last five years longer. The remaining span,

over the tracks used for the storage of passenger cars, is in good condition. The lower floor of the whole bridge was relaid with kyanized spruce, and one sidewalk was newly concreted.

#### SWETT-STREET BRIDGES (OVER SOUTH BAY SLUICES).

These are wooden bridges, and were built in 1875.

The easterly bridge will need sheathing next season; the westerly bridge has been put in good order. The abutments of both of these bridges are spruce pile bulkheads, and are in bad condition, and it will be necessary to make extensive repairs on them. The railings of both bridges have been painted.

#### \*WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).

This is a wooden pile bridge with an iron draw; it was originally built in 1828, and the present structure was built in 1883-84.

But few repairs were required during the past year, and the bridge is in good order. Two new water-pipe siphons have been laid across the channel, and a 16-in. and a 30-in. water-pipe have been laid across the bridge under the westerly sidewalk, excepting for a short distance near the Boston end, where they are laid under the roadway.

#### WEST CHESTER PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This is an iron bridge, and was built in 1876.

It has been stripped of its wood-work, has been painted, and the wood-work renewed. The objectionable curve in the profile of the bridge has not been changed. It is in good condition.

#### WEST CHESTER PARK BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).

This is an iron bridge, and it was built in 1876.

Only the ordinary repairs have been required, and the bridge is in fair condition.

#### WEST RUTLAND-SQUARE FOOT-BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).

This is an iron bridge; it was built in 1882, and is in good condition. It has been painted.



**WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP).**

This is a pile bridge without a draw; it was originally built in 1839, was rebuilt in 1851, and was extensively repaired in 1870.

It has been strengthened at a point where a pile was found to be almost eaten off by the *limnoria*. The fences have been repaired and the sheathing patched. The bridge is old and poor, and will last but a few years longer. There seems to be no reason why nearly the entire length of it cannot be filled solid at a moderate expense, and without damage to any other interests.

**II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.****\*CAMBRIDGE-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This is a wooden pile bridge with a wooden leaf draw. It was rebuilt in 1884. It has been painted; the draw-pier needs replanking; otherwise the bridge is in good condition.

The cables of the West End Street Railway Company, for carrying the power from their Allston power-station to Cambridge, cross this bridge, and a small cable-house has been built on the draw-pier.

**CENTRAL-AVENUE BRIDGE (OVER NEPONSET RIVER, DORCHESTER LOWER MILLS).**

This is an iron bridge, and was built in 1876.

The sidewalks are poor, and the under-floor is in poor condition. The bridge should be stripped, the wood-work renewed throughout, and the iron-work painted. The iron-work, being over fresh-water, is in good condition.

**\*CHELSEA BRIDGE, NORTH (FROM MYSTIC-RIVER CORPORATION WHARF TO CHELSEA).**

The original structure was built in 1802-3; the present structure was built in 1880, except the draw, which was built in 1873.

The draw is old and in poor condition, and will require extensive repairs. The bridge near the draw will also require some repairs; but for most of its length it is in good condition.

**\*ESSEX-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This is a wooden pile bridge with a wooden leaf draw, and was originally built in 1850.

Only slight repairs have been made; the widening of Commonwealth avenue and the widening of the water-ways, as required by the Legislature, would seem to be sufficient reasons for the construction of a new bridge in place of the present one, especially as it is old and poor.

**\*GRANITE BRIDGE (FROM WARD 24 TO MILTON).**

This bridge was originally built in 1837. It is a wooden pile bridge with a wooden leaf draw.

The water-way has been widened from 31 feet to 36 feet, in the clear. The draw is a new one, of the same type as the former one; namely, a wooden leaf or lifting draw, raised by hand-power. The cut for widening was made on the Boston side of the bridge, and no work was done except such as was required to carry out the order of the Legislature under which it was done; namely, to widen the passageway for vessels to 36 feet. The work was done by the city of Boston, the town of Milton paying two-thirds the cost. A contract was made with Mr. George H. Cavanagh for the whole work for \$3,975. Forty-nine oak piles, in good condition, drawn up from Neponset bridge, and which were too short for use in that bridge, were used here, thus reducing the cost to the city of Boston by \$300. The total cost of the work to the city of Boston, including inspection, was \$1,085.08.

**LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOKLINE).**

The present structure was built in 1877. This is a wooden bridge on wooden posts set in the ground.

It is in fair condition. The portion maintained by Boston, being at the foot of a hill, is usually in bad condition, on account of the mud and dirt washed upon it by rains.

**MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).**

This is an iron bridge, and is in bad condition; the abutments and centre pier are very poor; the iron-work is too light, and is very rusty. The wood-work is very old and poor, and the bridge is below the grade of its approaches.

It is a small bridge of two short spans, and its safety is only assured by a few large sticks of timber under the road-

way, which were put in a few years ago. One-half of the bridge is maintained by the town of Milton. The bridge should be rebuilt at once.

**MILTON BRIDGE (FROM WARD 24 TO MILTON).**

The original structure is very old; it was widened in 1871-72. The older part of this bridge was built of stone, and the widening is an iron structure on stone columns. No repairs of consequence have been made during the past season. It should be thoroughly overhauled and repaired this season. The stone-work of the old part of the bridge is in poor condition.

**\*NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).**

The original structure was built in 1802; the present structure in 1877. This bridge is a wooden pile bridge with an iron leaf draw; both leaves of the draw are maintained by Boston. The passageway for vessels has been widened from 31 feet to 36 feet. The leaves of the old draw were each lengthened 2 feet, new foundation piles and timber were provided, and the bridge presents the same general appearance as formerly. The work was done by contract by John N. Hayes & Co., and the total cost, including inspection, was \$6,912.33. The fixed part of the bridge was not changed, and the piers remain as before, excepting the parts renewed and replaced at the time of widening. The bridge is in good condition.

**\*NORTH BEACON-STREET BRIDGE (FROM BRIGHTON TO  
WATERTOWN).**

This is a wooden pile bridge with a wooden leaf draw. The original structure was built in 1822, and the present structure in 1884.

The roadway has been sheathed. The bridge is in good condition.

**\*NORTH HARVARD-STREET BRIDGE (FROM BRIGHTON TO  
CAMBRIDGE).**

This bridge was originally built in 1662, and was rebuilt in 1879.

It has been painted. The abutment maintained by Boston is in poor condition; the draw-pier is in poor condition, and is placed at such an angle as to obstruct the use of the

present width of the draw. When the water-way is widened it will be necessary to rebuild the pier.

**SPRING-STREET BRIDGE (FROM WARD 23 TO DEDHAM).**

This is a stone bridge, and it is in good condition.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The original structure was built in 1824; the present structure was built in 1879-80.

It has been painted, and is in good condition.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge. It was built in 1824, the present draw was built in 1883, and the abutment was rebuilt in 1886.

The draw-pier has been repaired; the bridge is in good condition.

**III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.**

**ALBANY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

The original structure was built in 1856-57; was rebuilt in 1867-68, and again in 1886-87.

It is an iron bridge; it has been sheathed, and is in good condition.

**\*CANAL BRIDGE (FROM BOSTON TO CAMBRIDGE).**

**\*PRISON-POINT BRIDGE (FROM CHARLESTOWN TO CAMBRIDGE).**

**\*WEST BOSTON BRIDGE (FROM BOSTON TO CAMBRIDGE).**

These bridges are in the care of two commissioners, appointed, one from Boston and one from Cambridge, and the expense of maintenance is borne equally by each city. The Boston Commissioner makes an annual report in print. (See City Doc. 20, 1890.)

Canal bridge is a wooden pile bridge with a wooden turn-table draw. The bridge was originally built in 1808; was rebuilt in 1852, and again rebuilt and widened in 1874; some of the piles in this bridge date from 1808. It has been repaired by driving new piles, and by strengthening the sides of the water-way, and by adding new girder-caps to the piles at the Boston end. The draw and engine-house have been painted, and considerable paving has been done.

The roadway is in poor condition; the floor should be examined, and nearly the whole bridge repaved. The piling at both ends of the bridge (the central part was rebuilt in 1874) is in poor condition, and repairs are needed upon it every year. The wooden draw is in fair condition, but is sixteen years old, and will consequently need constant repairs to keep it in use hereafter.

Prison-point bridge was originally built in 1833, and the present structure was built in 1876-77. It is a wooden pile bridge with an iron leaf draw.

The wood-work on the draw has been renewed, and the machinery for hoisting it is in process of repair. The bridge is in fair condition.

West Boston bridge was built in 1792-93, was rebuilt in 1854, and repaired in 1871; the draw was rebuilt in 1875, and the down-stream sidewalk on the Cambridge side of the draw was rebuilt in 1886. It is a wooden pile bridge with a wooden turn-table draw.

The piles under the main roadway have been strengthened by adding new girder-caps, and part of the roadway has been repaved. Repairs have also been made to the draw. It will be necessary to rebuild the up-stream sidewalk from the draw to Cambridge at an early day.

As a whole the bridge is old, narrow, and poor. It is no wider than it was in 1854, and the travel over it has greatly changed and increased, and is now very large. The draw, built in 1875, has almost reached the limit of life for a wooden structure of its character. It will be necessary to rebuild the entire bridge before many years.

#### DORCHESTER-STREET BRIDGE (OVER OLD COLONY RAILROAD).

This is an iron bridge; it was built in 1869.

The recommendation made last year is renewed. It is known to be in poor condition, and it should be stripped of wood-work to allow the condition of the iron-work to be more clearly ascertained than can be done otherwise.

**\*HARVARD BRIDGE (FROM BOSTON TO CAMBRIDGE).**

This is still in the hands of the Commissioners, but is practically completed.

**IV. — BRIDGES SUPPORTED BY RAILROADS.**

Tremont-street bridge, over the B. & A. R.R., is now being rebuilt by the Boston & Albany Railroad Corporation, and the Washington-street bridge, over the same road, is to be rebuilt at once by the same corporation. The bridges over the Eastern and Western divisions of the Boston & Maine Railroad on Main street and Mystic avenue, Charlestown, are in poor condition. The two Norfolk-street bridges in Dorchester, over the N. Y. & N. E. R.R., need attention; the trusses are boxed in and their condition cannot be determined, but enough can be seen to show that they need examination and adjustment. The walls of the South Boston cut on the same road, which also form the abutments of several bridges, are in poor condition.

The other bridges given in the list of those supported by railroad corporations require no special mention.

**LIFE OF BRIDGES OVER RAILROADS.**

The preservation of iron-work exposed to the sulphurous gases contained in the smoke from locomotives is a problem which has not yet been satisfactorily solved.

Linseed-oil paints do not form a perfect protection to the iron where there is much traffic under the bridge, especially where the distance from bridge to railroad tracks is but fifteen feet, as is the case with most of our bridges; the gases in the smoke easily destroy these paints, and expose the iron to corrosion and rust. Of the oil paints yet used, red-lead, properly applied, has thus far given the best results.

The painting of the iron-work under the flooring of a bridge is often inefficiently done, and is expensive and dangerous work to do. To thoroughly examine and paint the iron-work below the flooring of a bridge it is necessary to remove the floor planking, and unless the planking needs renewing, this is expensive and inconvenient. Untreated spruce planking will need renewing at intervals of about four years, and it is hoped that some paint or coating for practical use will soon be discovered which will protect the iron for at least this time, so that the use of such paint at the time of laying the flooring will afford protection to the iron until the floor is renewed.

Until such paint is found, the yearly painting of iron-work exposed to engine-smoke should be continued, as being the best method of partial protection at hand.

## MISCELLANEOUS WORK AND CONSTRUCTION IN 1889.

### BOLTON-STREET BRIDGE (OVER N. Y. & N. E. R.R.).

This is a small wooden bridge, 28 feet clear span and 20 feet wide, built over the South Boston cut of the New York & New England Railroad. It is a platform of hard-pine stringers covered with spruce plank, and was built by Joseph Shaw, from designs prepared by this department, at a cost of \$850.14. By agreement with the railroad corporation the City of Boston builds and maintains the bridge at a grade of 15 feet above the tracks, and agrees to become responsible for all accidents of whatever nature, and to remove the bridge whenever required to do so by the railroad.

### BYRON-STREET BRIDGE (OVER B., R. B., & L. R.R.).

At the request of the Superintendent of Streets, plans and specifications were prepared for this bridge, and a contract for building the same was entered into with Josiah Shaw, Aug. 13, 1889.

This structure supersedes a narrow wooden bridge built by the railroad company at the time its road was constructed. The width of the bridge is 40 feet, divided into one 30-foot roadway and two 5-foot sidewalks.

The total length of the bridge is about 79 feet, and comprises three spans, the middle span over the tracks being 32 feet 8 inches from centre to centre of trestle bents, and the end spans, over the side slopes of the railroad cut, being about 20 feet and 25 feet span respectively.

The end spans have seven lines of hard-pine beams, each beam being made up of two 7-inch  $\times$  14-inch sticks bolted together. The beams of the middle span are each made of two 6-inch  $\times$  12-inch sticks, trussed by a  $\frac{1}{4}$ -inch diameter iron rod. The end supports for the bridge consist of timber bulkheads, and the two intermediate supports are trestle bents of hard-pine timber, resting on rubble-masonry walls, which are built high enough to hold the side slopes of the railroad cut.

The roadway planking is of spruce, the under course being four inches thick and the upper or sheathing course

being two inches thick. The sidewalk is planked with 3-inch planed hard-pine.

The stone walls before mentioned were not included in the original design, but were built by the railroad company, under an agreement with the contractor and the city, the work being supervised by this department. No settlement with the railroad company has yet been made.

The cost of the bridge, not including unpaid claim of railroad company, was \$3,593.

#### COMMONWEALTH-AVENUE WIDENING.

A contract was drawn for the filling of Commonwealth avenue an additional width of one hundred feet, from Beacon street to Cousens' wharf, the distance being about 3,600 feet. The ground to be covered by the widening has been cross-sectioned, and approximate estimates of the quantity of filling deposited have been made, from time to time, as requested by the Superintendent of Streets. Plans and specifications were prepared for two bulkheads across creeks, on the outer line of the widening, and their construction supervised. These bulkheads were respectively 230 feet and 620 feet long. They were built by John T. Scully, at a cost of \$3,875.

#### COTTAGE-STREET FOOT-BRIDGE.

This bridge is for foot travel only, and is built on the line of Cottage street, East Boston, from Maverick street across the flats to Prescott street, a distance of 3,546 feet. Its width is 12 feet.

The bridge is built with spruce piles, stringer and plank, and hard-pine fence posts. The work was done by Josiah Shaw and Horace Sias, and cost \$11,154.67.

#### GRANITE CURBING, CITY SQUARE.

Plans and specifications for a granite curbing around a grass plot at City square, Charlestown, were made, and the work supervised. The curbing was furnished and set by John Turner & Co., at a cost of \$588.

#### L-STREET BULKHEAD.

Plans and specifications were made for a wooden bulkhead, which has been built on the line of L-street extension, South Boston. The work was done by Josiah Shaw, and cost \$5,356.03.



**LEYDEN-STREET BRIDGE (OVER B., R. B., & L. R.R.).**

The bridge was built by this department, in accordance with an order of the City Council, approved Jan. 26, 1889.

The clear span at right angles to railroad tracks was fixed by the railroad company at 35 feet, and both abutments of the bridge are practically within the railroad location.

The abutments are built of granite, with the exception of their foundation courses, which are made of cement concrete.

The main walls of the abutments are of rubble masonry, laid in cement mortar; the front of the walls showing quarry-faced, straight-split stones, in courses of nearly even rise. The bridge seats and parapets are rough pointed. The extreme length of each abutment is 139 feet.

The superstructure is a thorough plate-girder bridge, with two main girders placed on outside lines of bridge, and 36 feet apart on centres. These girders are 68 feet long over all, and 5 feet deep from out to out of flange angle-irons. Floor-beams are built iron girders, and the lateral system is made of angle-irons and rods.

The bridge has one roadway 26 feet wide, and two sidewalks, each 5 feet wide.

The roadway and sidewalk stringers are of hard-pine, the under-floor of roadway is 4-inch thick spruce, and the upper course of plank is 2-inch spruce, planed to an even thickness and laid diagonally. The sidewalk plank is 2-inch white-pine, planed and jointed.

The iron-work below floor level, including inside faces of main girders, is painted with two coats of "P. & B. paint."

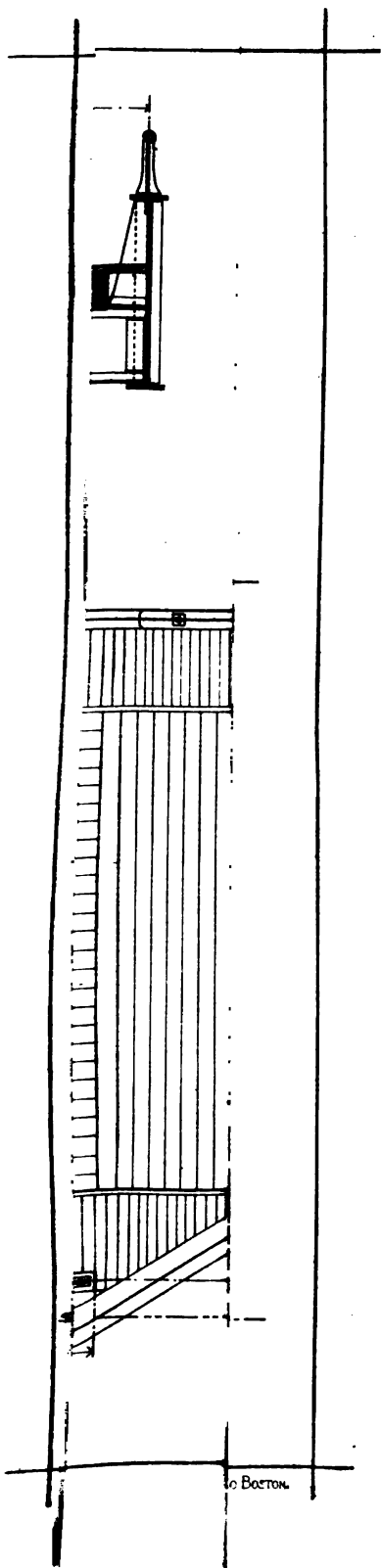
The contract for the abutments was awarded to Turnbull & Cheney, who afterward assigned the same to D. Henry Cram, by whom the work was completed.

The superstructure was built by the King Iron Bridge & Manufacturing Company, of Cleveland, O., from plans furnished by this department.

The total expenditure for the work by this department was \$15,819.55.

**WALKS IN COMMON AND SQUARES.**

The work of laying walks with Hastings' Compressed Asphalt Tiles, for the Department of Common and Public Grounds, has been supervised in three localities. The work was done by John Turner & Co., and the cost was as follows:—





Winthrop square, Charlestown . . . .	\$356 00
Boston Common . . . . .	5,700 00
Belmont square, East Boston . . . .	1,300 00

Other work of a miscellaneous character was principally as follows :—

#### PLANS AND SPECIFICATIONS.

For water-pipes on Huntington-ave. bridge.  
 For Gold-st. foot-bridge.  
 For sidewalk curb at New Court-house.  
 For foundation for statue of Colonel Cass.

#### PLANS AND ESTIMATES.

For retaining-wall on 30-foot street at Harvard bridge.  
 For retaining-wall for East Boston ferries.  
 For bulkhead on Bothnia street.  
 For Gold-st. foot-bridge.

#### ESTIMATES.

For Northern avenue or Oliver-street bridge.  
 For bridge over Reserved channel, on line of Congress and L streets.  
 For retaining-wall and filling for extension of L street to Reserved channel.

Reports were made to the Superintendent of Sewers on the condition of a retaining-wall at Dorchester-ave. bridge, over the N. Y. & N. E. R.R. ; and to the Superintendent of Common and Public Grounds, on the condition and merits of certain concrete foot-paths on Telegraph Hill, South Boston. The wall above referred to has since been rebuilt by the railroad company at its own expense.

A large amount of work of a miscellaneous character has also been done during the year. Under this head may be classed record-plans, maps for Water-Works and Park Department, copying, tracing, and blue-printing plans.

## B. — WATER WORKS.

[FROM THE CITY ENGINEER'S REPORT TO THE BOSTON  
WATER BOARD.]

### SOURCES OF SUPPLY.

The rainfall was above the average during the past year, and was so evenly distributed that there has been an abundant supply of water at all times.

The rainfall and quantities collected on the several watersheds are as follows:—

	Sudbury.	Cochituate.	Mystic.
Rainfall, inches,	49.95	50.23	50.395
Rainfall collected, inches,	29.056	27.95	25.48
Daily average yield, gallons,	104,030,000	25,112,000	32,601,000

The quality of the water from the Sudbury and Cochituate supplies has been good, and no trouble has been experienced from algæ.

The quality of the Mystic water appeared to be better than usual, probably owing to the large rainfall of the last two years.

The fluctuations in the amount of storage in the different lakes and reservoirs are shown graphically by an appended diagram. The condition of the different reservoirs during the year is given below.

### SUDBURY-RIVER RESERVOIRS AND LAKE COCHITUATE.

*Reservoir No. 1.* — Water was wasting at the outlet dam during the whole year, with the exception of from May 10 to 20, and June 13 to 16. The reason no water was wasted during these two periods was, that the flash-boards were placed on the dams.

*Reservoir No. 2.* — This reservoir has been full the greater part of the year; the lowest point reached being on November 2, when the water stood at grade 159.38, or 6.51 feet below the crest of the dam.

*Reservoir No. 3.* — This reservoir has been full and overflowing all the year, with the exception of nine days in September, of seven days in October, and of one day in November. The lowest point reached during the year was on September 30, when the surface of the water stood at grade 174.80, or 0.45 feet below the crest of the dam.

*Reservoir No. 4.* — This reservoir has been kept at or near high-water mark during the whole year. The lowest point reached being on May 15, when the surface of the water was at grade 214.37, or 0.84 feet below the top of the flash-boards.

*Farm Pond.* — The surface of the pond has been kept at an average level of 149.44 feet above tide-marsh level.

The conduit through the pond has been used during the whole year. No water was used from this pond during the year, on account of the fear that there might be danger from the Framingham drainage.

The Framingham Water Company has pumped 59,500,000 gallons from the pond, or an average of 163,000 gallons per day.

*Lake Cochituate.* — Water was wasting at the outlet dam during the greater part of January, February, and March; also from May 23 to 26, June 3 to 6, and August 3 to 26.

The water in the lake was drawn down about three and one-half feet in August, to allow work to be begun on the new outlet dam.

A contract for the building of the dam was made with Thomas A. Rowe, on August 17. Work began immediately, and continued until December 23. The portion of the work below the original surface is so far completed that the dam can be easily finished next season, all the difficult work being done.

The heights of water in the various storage reservoirs on the first day of each month are given on next page.

	RESERVOIRS.				FARM POND.	LAKE COCHITU ATE.
	No. 1.	No. 2.	No. 3.	No. 4.		
	Top of flash- boards, 159.39.	Top of flash- boards, 167.12.	Crest of Dam, 175.24	Top of flash- boards, 215.21	High Water, 149.25.	Top of flash- boards, 124.36.
January 1, 1889 . . . . .	158.11	166.26	175.60	214.62	149.25	120.71
February 1, " . . . . .	158.07	166.23	175.51	214.63	149.56	122.67
March 1, " . . . . .	157.80	166.02	175.32	214.44	149.53	122.21
April 1, " . . . . .	157.90	166.12	175.48	214.43	149.24	122.43
May 1, " . . . . .	158.07	166.23	175.60	214.59	149.43	123.61
June 1, " . . . . .	159.52	167.32	175.47	215.12	149.41	124.23
July 1, " . . . . .	159.31	168.40	175.34	214.91	149.29	123.11
August 1, " . . . . .	159.38	167.42	175.75	215.17	149.66	123.47
September 1, " . . . . .	157.68	166.43	175.40	215.02	149.34	120.73
October 1, " . . . . .	157.84	167.28	174.84	215.06	149.53	120.95
November 1, " . . . . .	157.98	159.52	175.53	214.52	149.20	121.43
December 1, " . . . . .	158.48	166.50	175.90	214.99	149.76	123.28
January 1, 1890 . . . . .	157.95	166.14	175.52	214.56	149.90	122.77

Water has been drawn from the different reservoirs in the Sudbury river to supply the city as follows :—

*Reservoirs No. 1 and No. 2.*

May 5 to May 17.

*Reservoir No. 2.*

Jan. 14 to Jan. 18.	Aug. 22 to Aug. 25.
April 26 to May 2.	Aug. 29 to Sept. 2.
May 18 to Aug. 4.	Sept. 6 to Sept. 7.
Aug. 6 to Aug. 11.	Dec. 24 to Dec. 30.
Aug. 13 to Aug. 19.	

*Reservoirs No. 2 and No. 3.*

Jan. 1 to Jan. 6.	Nov. 9 to Nov. 11.
Jan. 9 to Jan. 10.	Nov. 15 to Nov. 18.
Jan. 12 to Jan. 13.	Nov. 22 to Nov. 25.
Jan. 19 to April 25.	Nov. 29 to Dec. 2.
Sept. 8.	Dec. 6 to Dec. 9.
Oct. 18 to Oct. 21.	Dec. 13 to Dec. 16.
Oct. 25 to Oct. 28.	Dec. 20 to Dec. 23.
Nov. 1 to Nov. 2.	Dec. 31.

*Reservoir No. 3.*

Sept. 9.	Oct. 2 to Oct. 7.
Sept. 12 to Sept. 16.	Oct. 11 to Oct. 14.
Sept. 20 to Sept. 24.	Nov. 3 to Nov. 5.
Sept. 28 to Sept. 30.	

## AQUEDUCTS AND DISTRIBUTING RESERVOIRS.

The Sudbury-river aqueduct has been in use during the whole or portions of 302 days, and the Cochituate aqueduct has been used 361 days.

During the last five months of the year the Sudbury conduit was used intermittingly, to allow the work of lining the Beacon-street tunnel to be done. Water was usually run through the conduit on Saturdays, Sundays, and Mondays, the work of lining being done during the balance of the week. The Sudbury conduit has delivered into Chestnut-Hill and Brookline reservoirs 6,130,500,000 gallons, equal to a daily supply of 16,796,000 gallons; and the Cochituate aqueduct has delivered 5,570,424,000 gallons, or 15,261,000 gallons per day.

Both aqueducts have been cleaned during the year. The details of this work will be seen in the report of the Superintendent of the Western Division. In the Cochituate aqueduct a flow 6 feet in depth was maintained until August 1, and from that date the depth was increased to 6½ feet.

The Chestnut-Hill, Brookline, Fisher-Hill, Parker-Hill, and East Boston reservoirs are in good condition. Parker-Hill reservoir was shut off from January 9 to October 16, and from November 1 to the present time.

## HIGH-SERVICE PUMPING-STATIONS.

The buildings at the Chestnut-Hill pumping-station were completed early in the year, and the grounds were graded and planted.

An electric-lighting plant of 108 incandescent lights was placed in the building during the past summer, which thoroughly lights all portions of the main building, the biological laboratory, and the stable.

The dynamo and lights were furnished by the Standard Electric Company, of Vermont.

The power is furnished by a 12-horse power Paine engine, which takes steam from the main boilers.

In the basement a lathe, planer, drill, emery-wheel, and grindstone have been set up, the power for running them being supplied by a water motor. A good set of carpenters'



and machinists' tools has also been furnished, and the ordinary repairs on the pumping-plant are made by the regular force, with the least possible expense.

The pumping-engines are kept in good condition. Independent jacket-pumps, furnished by H. R. Worthington, have been attached to each engine, and by this arrangement all the steam used in the jackets of the steam cylinders is returned to the boilers, whether the pumping-engines are running or not.

Air chambers have been placed on the suction-pipes of both pumps, and several minor changes and repairs have been made by the regular force of engineers at the station.

An attachment for admitting air to the furnace at the bridge-wall, known as "Jones' economic furnace," was placed under each boiler, and put into operation on October 1. The greater portion of the soot which formerly collected in the flues is now consumed, and the evaporation of water by the boilers per pound of coal burned seems to have been increased by this appliance.

The amounts of water pumped at the Chestnut-Hill pumping-station, and the percentage of increase over the corresponding months in 1888, are as follows: —

	Total amount pumped.	Daily average amount pumped.	Per cent. increase.
January . . . . .	174,117,800	5,616,700	20.7
February . . . . .	170,303,500	6,063,300	20.7
March . . . . .	177,191,760	5,715,900	23.7
April . . . . .	162,630,250	5,417,700	31.1
May . . . . .	183,062,250	5,905,300	43.2
June . . . . .	183,873,500	6,129,100	27.4
July . . . . .	187,811,760	6,058,400	9.8
August . . . . .	188,040,100	6,065,800	10.1
September . . . . .	189,435,725	6,314,500	18.4
October . . . . .	182,895,575	5,899,900	16.1
November . . . . .	169,846,250	5,661,500	11.9
December . . . . .	174,817,300	5,639,300	2.8
Total and average . . .	2,143,925,750	5,873,700	19.1

Several large districts, formerly supplied from the low service, were connected with the high service in June, 1888; consequently the percentage of increase shown for the first

half of 1889 is larger than it should be expected to be in the future. The average increase during the last half of this year, when the districts supplied practically corresponded with that supplied during the corresponding months of the previous year, was 11.4 per cent.

The season was, however, very favorable for a small consumption of water during this latter part of the year, and the increase of 11.4 per cent. is probably too small for estimating the probable increase for future years. I think that 13 per cent. would be more nearly correct to use.

Upon this basis the average consumption will exceed the capacity of one of the pumping-engines within two and one-half years, and arrangements have consequently been made for procuring a third pumping-engine.

The table on page 42 shows the work done by the pumping-engines during the year.

Engine No. 1 was in use 3,616 hours,	
pumping . . . . .	1,223,540,500 galls.
Engine No. 2 was in use 2,785 hours,	
45 minutes, pumping . . . . .	920,385,250 "
<hr/>	
Total amount pumped . . . . .	2,143,925,750 "
Total amount coal consumed . . . . .	2,462,751 lbs.
Per cent. ashes and clinkers . . . . .	7.9
Average lift in feet . . . . .	123.21
Quantity pumped per lb. of coal . . . . .	870.5 galls.
Daily average amount pumped . . . . .	5,873,700 "

The duty of the engines is calculated after deducting 2½ per cent. from the theoretical displacement of the plungers for slip, and with no credit given the engines for the large amount of steam used to heat and light the pumping-station and adjacent buildings, and corrected duties, are also shown in the tables. The exact amount of steam used for heating the building was shown by a meter; the amount of coal used to run the dynamo was assumed, after making calculations and experiments, to be 30 pounds of coal per hour of lighting.

#### *Cost of Pumping.*

Salaries . . . . .	\$9,488 99
Fuel . . . . .	5,465 70
Repairs . . . . .	1,046 94
Oil, waste, and packing . . . . .	664 99
Small supplies . . . . .	177 82
<hr/>	
Total . . . . .	\$16,844 44

Cost per million gallons raised one foot high, 6.37 cents.

Cost per million gallons pumped to reservoir, \$7.86.

The above includes the cost of heating and lighting.

At the West Roxbury pumping-station 12,903,700 gallons have been pumped, equivalent to a daily average of 35,350 gallons, or a decrease of 12.9 per cent. from the amount pumped in 1888. This decrease was owing to the mild winter, a smaller amount than usual being allowed to run back into the main high service, to prevent the freezing of the pipe over Park-street bridge.

The grounds around the Bellevue tower have been graded, and a roadway built.

The new pumping-station in East Boston has been completed, and is now in running order.

Breed's Island has been supplied with water from the new supplementary high service since August 28th, and an observatory tower, similar to the one on Bellevue hill, has been built over the tank. The height of water in the tank is indicated and recorded at the pumping-station, 11,000 feet distant, by an electrical gauge and indicator, made by George E. Winslow, of Waltham.

No water has been pumped into the East Boston reservoir during the year, since the increased head, due to the 24-inch main laid in 1888, enables the reservoir to be filled during the night without the aid of the pumps.

This condition will continue, excepting during unusually cold weather, or while one of the mains may be temporarily shut off.

About 7,000 gallons per day are pumped into the tower on Breed's Island.

#### MYSTIC LAKE.

The surface of the lake has been kept in the vicinity of high-water mark during the greater part of the year, and water was wasted over the dam on 299 days. In November the lake was lowered to about four feet below high-water mark, so that the rip-rap on a portion of the dam between the overflow and the gate-house could be repaired.

The yield of the water-shed is shown on page 41.

#### MYSTIC-VALLEY SEWER.

The works for the purification of the sewage have been in successful operation during the year. The total amount pumped and treated was 99,882,850 gallons, or 324,000 gallons per day, exclusive of Sundays and legal holidays, when the pumps are not run.

Four hundred and four thousand two hundred and seventy pounds of sulphate of alumina have been used in purifying the sewage, and 162 tons of coal were used in pumping.

The cost of pumping and treating the sewage was \$152.46 per million gallons treated. This price does not include extra work about the grounds, or the care of the main sewer and its branches.

#### MYSTIC CONDUIT AND RESERVOIR.

The conduit has been cleaned twice during the year, and is in good condition. The north-eastern division of the reservoir should be cleaned during the coming year, and such repairs made as are found to be necessary.

#### MYSTIC PUMPING-STATION.

The 8,000,000-gallon pump was overhauled during the year, and was fitted with new valve-rods. It is now in good condition.

An independent air-pump and condenser has been contracted for, to connect with the two 5,000,000-gallon pumps, their old air-pumps being worn out. By this improvement the efficiency of these two pumps will be considerably increased.

The four boilers that were erected in 1872 are to be replaced by three new boilers during the coming summer.

A lathe, driven by a Tuerk water-motor, has been placed in the basement of the engine-room, and has proved to be of great assistance in making repairs to the pumps.

The table on page 43 shows the work done by the pumping-engines during the year.

Engine No. 1 was in use	494 hours, 45 minutes	pumping	75,182,900 gallons.
" " 2 "	" 1,224 " 30 "	"	233,123,900 "
" " 3 "	" 7,993 " 30 "	"	2,649,657,600 "
Total amount pumped . . . . .			2,857,960,400 "

Total amount of coal consumed, 6,286,000 lbs.

Percentage ashes and clinkers, 8.

Average lift in feet, 146.51.

Quantity pumped per pound of coal, 454.7 gallons.

Average duty of engines per 100 lbs. of coal, no deductions, 55,554,200 ft.-lbs.

Daily average amount pumped, 7,830,000 gallons.

#### Cost of Pumping.

Salaries . . . . .	\$9,922 08
Fuel . . . . .	14,262 93
Repairs . . . . .	123 64
Oil, waste, and packing . . . . .	690 66
Small supplies . . . . .	406 79
Total . . . . .	<u>\$25,406 10</u>

Cost per million gallons raised one foot high . . \$0.0607  
 “ “ “ “ pumped to reservoir . . 8.89

### CONSUMPTION.

The daily average consumption from the combined works, and the consumption compared with that of 1888, has been as follows : —

1889.	COCHITUATE WORKS.		MYSTIC WORKS.		COMBINED SUPPLY.	
	Consumption in Gallons.	Percentage of Consumption of 1888.	Consumption in Gallons.	Percentage of Consumption of 1888.	Consumption in Gallons.	Percentage of Consumption of 1888.
January . . .	30,172,000	74.5	7,769,500	70.0	37,941,500	73.5
February . .	35,855,200	83.2	9,073,600	78.1	44,928,800	82.1
March . . . .	32,180,000	88.3	7,537,600	81.6	39,717,600	86.9
April . . . .	30,814,500	97.9	7,185,700	98.7	38,000,200	98.1
May . . . . .	32,719,500	106.2	7,663,600	110.5	40,383,100	107.0
June . . . . .	33,377,900	107.6	8,017,700	106.3	41,395,600	107.1
July . . . . .	31,870,300	99.5	8,315,600	100.6	40,185,900	99.8
August . . .	31,408,200	96.8	8,113,200	103.2	39,521,400	98.1
September . .	31,722,800	99.6	7,966,000	109.6	39,688,800	101.5
October . . .	31,702,200	108.9	7,627,500	107.5	39,329,700	108.0
November . .	31,532,400	110.3	7,316,700	104.7	38,849,100	109.2
December . .	31,839,000	97.4	7,473,200	94.4	39,302,200	96.8
Average . . .	32,070,000	96.3	7,830,500	94.8	39,900,500	96.0

The daily average consumption per head of population has been as follows : —

Sudbury and Cochituate supply . . . . 82.7 gallons.  
 Mystic supply . . . . . 70.4 “  
 Combined supplies . . . . . 80.0 “

The above figures show a decrease of 3.7 per cent. in the consumption from the Sudbury and Cochituate works from that of the previous year; of 5.2 per cent. in the consumption from the Mystic works; and of 4 per cent. decrease in the consumption from the combined supplies.

## DISTRIBUTION.

The following changes were made in the distribution system during the year : —

SIZE.	SUDBURY AND COCHITUATE WORKS.		MYSTIC WORKS IN CHARLESTOWN.	
	Total length laid and relaid.	Length abandoned.	Total length laid and relaid.	Length abandoned.
4"	273	2,430	1,621	2,942
6"	58,778	7,049	7,866	5,110
8"	20,943	1,054	1,507	454
10"	3,133	922	...	...
12"	24,758	626	...	...
16"	3,276	...	...	...
20"	15,785	...	...	...
30"	1,808	...	...	...
Total length.	133,754	12,081	10,994	8,506

The total length of pipe laid on the Sudbury and Cochituate works was 25.3 miles, and 2.3 miles have been abandoned, making a net increase of twenty-three miles in the total length in use. On the Mystic works in Charlestown the mains were extended 569 feet; 1,919 feet of 2-inch service-pipes were relaid with 4 and 6 inch main pipes, and 8,506 feet of 4, 6, and 8 inch wrought-iron and cement pipes were replaced with cast-iron pipe.

The 30 and 16 inch mains, which were partly laid in 1888 to connect Charlestown with the Cochituate supply, were completed in December, by laying them across Warren bridge, siphons being placed under the channel at the draw-opening. The siphons consist, one of a 20-inch pipe, and the other of a 30-inch pipe, encased in a substantial box, made of hard pine, with the space between the pipe and the sides of the box filled with hydraulic cement-concrete. The siphon was so placed that in the channel the top of the box would be twenty-three feet below mean low water, being three feet lower than the 24-inch siphon that was laid on the other side of the bridge in 1883. The contract for building and lowering these siphons was awarded to John Cavanagh & Co., for \$14,700.

The method formerly employed for lowering siphons similar to these usually closed the river to navigation for at least three days. Before advertising for proposals for building

these siphons the subject of lowering them was carefully studied in consultation with Mr. Francis Low and Mr. John Cavanagh, with the result that the length of time during which navigation should be delayed by the lowering of each siphon was limited to twenty-four hours, and the specifications provided that only approved methods should be employed for lowering them. The method employed by the successful bidders was as follows:—

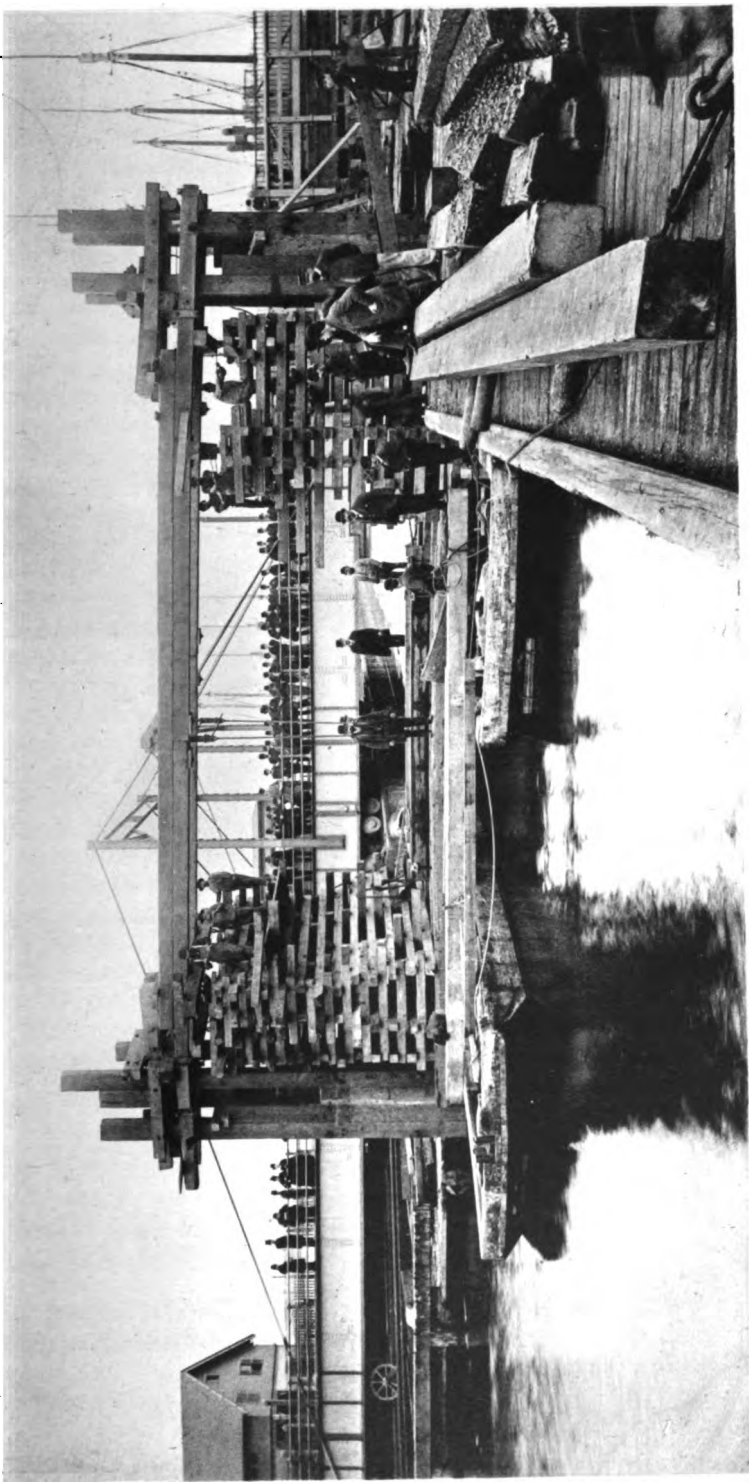
The siphons were partially built on the shore of Chelsea creek, nearly three miles from Warren bridge. After they were so far finished that when in place the arms would be above mean low water, they were moved on rolls to a point on the beach just above low water, and were then raised to a vertical position by means of screws. Each siphon was moved and placed separately. Two long and narrow scows were procured, one of which was secured to each side of the siphon, so as to float the siphon at flood-tide. The scows and suspended siphon were then towed through three draw-bridges to a point above Warren bridge. The scows were then changed from the sides of the siphon to positions between the vertical arms of the siphon, and the siphon was then floated over its final position at high water. The lowering into place was done by means of screws, assisted by the falling tide, and the channel was obstructed only during the ebbing of one tide for about six hours.

The 30-inch siphon was lowered on November 14 and the 20-inch on November 23. The illustration on opposite page shows the 30-inch siphon ready for lowering into place.

The beds for the siphons had to be dredged at least 10 feet below the bottom of the channel, and it was necessary to remove large portions of the draw-pier and wharf to accommodate the dredger. The 30 and 16 inch pipes were laid under the bridge and upon the draw-pier and wharf. The boxes to enclose and support the pipes were built by J. N. Hayes & Co., the greater portion of it by contract and a small portion by day's work. This work will be completed during the present month.

The laying of these pipes completes the "Connection with Charlestown" and "New Main to East Boston," which were begun in 1887; and Charlestown can now be supplied with water from both the low and high Sudbury and Cochituate services, if any emergency should arise in connection with the Mystic supply.

A 20-inch high-service main was laid from Parker-Hill reservoir to Boston Common, a distance of 15,948 feet. A right of way, 400 feet long and 10 feet wide, was secured through land of Franklin Dexter on Parker Hill, between



BOSTON.

HELIOTYPE PRINTING CO.,

# THIRTY INCH SIPHON AT WARREN BRIDGE.

NOV. 13. 1889.





Parker Hill avenue and Hillside street. This shortened the length of the pipe line about 1,200 feet from that originally estimated upon, and was secured without any expense to the city. The main is laid over the Boston and Albany railroad at Huntington-avenue bridge, a wrought-iron pipe being used at that point; and the 16-inch low-service pipe, formerly laid upon the sidewalk of that bridge, was replaced by a wrought-iron pipe, both pipes being laid below the floor of the sidewalk.

Considerable delay was experienced in procuring the wrought-iron pipes; but water will be let into the pipe by the middle of the present month. This main will increase the pressure on the pipes near Beacon Hill about 10 pounds during the hours of greatest consumption.

A 16-inch high-service main was laid from Parker street to Walnut avenue near Egleston square, a distance of 6,145 feet, and the 12-inch pipe was connected through Seaver street. These mains give 12 to 14 feet additional head to the services on Elm Hill during the hours of greatest consumption, and no complaints of an insufficient supply have been heard since this connection was made.

The supply in Dorchester was improved by laying 3,900 feet of 12-inch pipe in Blue Hill avenue, from Grove Hall to Abbot street; 1,740 feet of 12-inch pipe in Mill and Preston streets, to Commercial Point; and by relaying 1,680 feet of 6-inch with 12-inch pipe in Savin Hill avenue.

The 6-inch pipe line to Long Island was completed during the year. The siphon and pipe-box at Neponset bridge were built and placed in position by J. N. Hayes & Co., the siphon, containing an 8-inch pipe, being lowered on Sunday, April 21.

The excavation for the pipe-trench on Long Island was done by inmates of Deer Island, and, in consequence, the completion of the work was somewhat delayed, so that the water was not turned on to the island until August 21.

#### ADDITIONAL SUPPLY.

On March 10 the preliminary work on Basin 5 on Indian brook was stopped for lack of funds, and was suspended until November 18, when a party began to run the final location lines for the changes of the road system in the vicinity of the basin.

In December borings were commenced to determine the location and character of the proposed dam, and the work of cross-sectioning the proposed basin was also commenced.

On November 25 the survey of Whitehall pond and adja-

cent territory was commenced and is now about completed. For particulars, see the following report of Desmond Fitz Gerald, Resident Engineer : —

BOSTON WATER WORKS,  
OFFICE OF ADDITIONAL SUPPLY,  
SOUTH FRAMINGHAM, MASS., Jan. 1, 1890.

WILLIAM JACKSON, ESQ., *City Engineer and Chief Engineer Boston Water-Works* : —

DEAR SIR, — I submit herewith a brief report of engineering work accomplished during the past year by the additional-supply force.

Between March 10 and November 18 no work was done on Basin 5, on account of lack of appropriation. On November 18 a party began the work of locating the new lines of the roads, slight changes having been made in the former lines. This work was completed on Dec. 28, 1889.

On December 12 a diamond drill was set up on the proposed line of the dam, and is still at work. Bed-rock was reached in the valley at a depth of 42 feet below the surface of the ground. The borings and test-pits have revealed the fact that the ground is full of heavy boulders and water, and the trench for the core-wall will be extremely difficult and costly to excavate. The test-pit on the southerly end of the dam was carried to the rock in December. Depth, 35 feet.

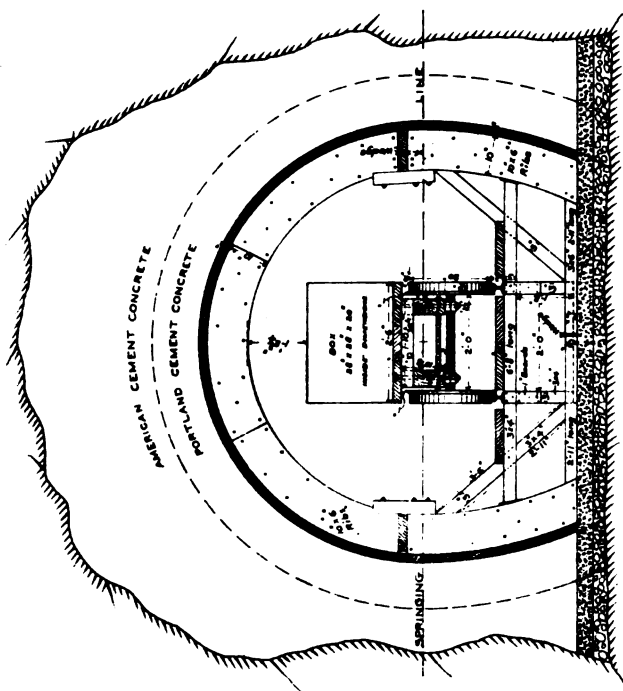
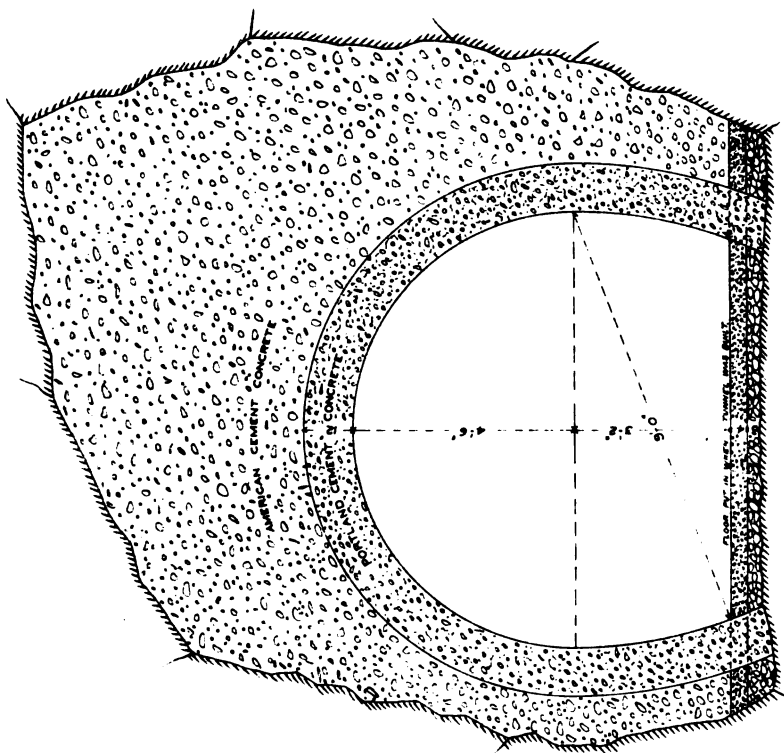
The engineering forces at the basin are now at work on the cross-sectioning of the valley, and getting out the quantities for the construction of the roads early in the spring. An artesian-well boring-machine will be started within a few days to hasten the borings, and a second diamond drill will be ordered.

A small force is now engaged in sinking a test-pit in the meadow by the brook.

On November 25 a party was started at Whitehall pond to make a survey of the pond and neighborhood. A taking-line has been located, contours run, and the work is now nearly completed. This party will then be moved to Cedar swamp.

During the summer, contours were made of the valley of Cold Spring brook, below Dam 4, with reference to improving the channel. This survey showed the necessity of lowering the bridge abutments of one of the Ashland highway bridges on Main street.

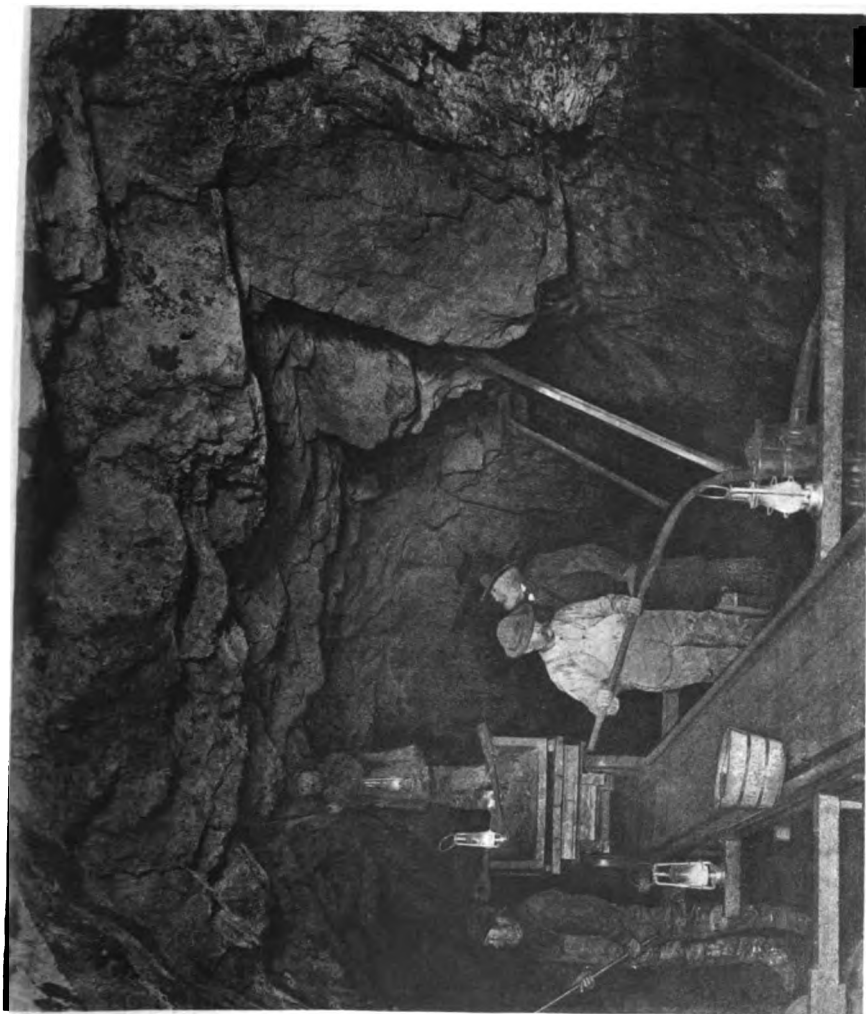
These abutments were accordingly rebuilt in October and November, permission therefor having been obtained from the selectmen of Ashland.



SECTIONS SHOWING LINING OF BEACON STREET TUNNEL-1889

Plate I





HELIOTYPE PRINTING CO.

4510708

BEACON ST. TUNNEL, SUDBURY RIVER AQUEDUCT.

PLATE 2.





BOSTON.

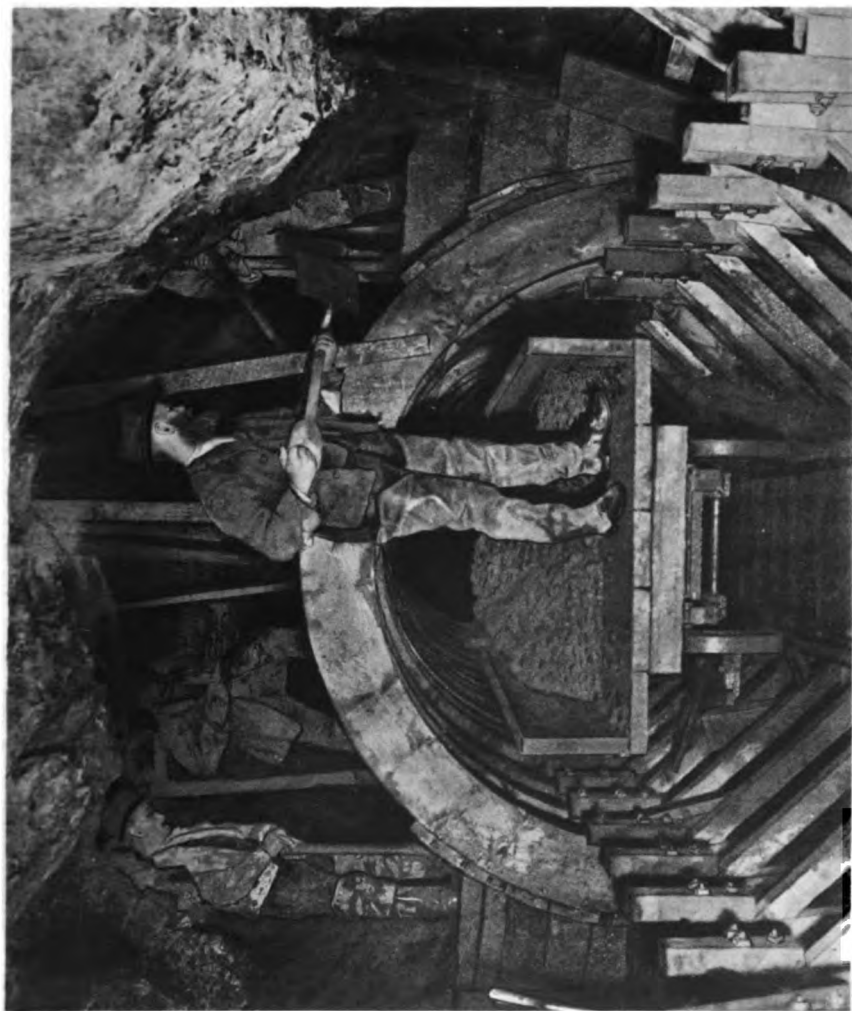
HELIOTYPE PRINTING CO.,

BEACON ST. TUNNEL. SUDBURY RIVER AQUEDUCT.

PLATE 3.







HELIOTYPE PRINTING CO.,

BOSTON.

BEACON ST. TUNNEL. SUDBURY RIVER AQUEDUCT.

PLATE 4.



Under the head of maintenance the following engineering work has been carried on during the year :—

Plans were made early in the season for lining portions of the Beacon-street tunnel of the Sudbury-river aqueduct, which were in a dangerous condition from disintegration of the rock. The greater part of the summer was spent in putting a track into the tunnel, and in preparing to do the work.

The laying of concrete was begun in September, and is still in progress.

A biological laboratory has been built, and a party organized for the study of changes in the life in the water, both animal and vegetable.

A new set of experiments has been started at Chestnut-hill reservoir on filtration.

The plant has been for the most part procured, but the preparation of the tanks was stopped by the cold weather. Work will be resumed early in the coming season, and it is hoped that filtration may be started in this experimental plant by the beginning of May. The design, which is closely modelled on the Lawrence experiments, has received the approval of Mr. Hiram F. Mills. The object is to determine the exact effect of intermittent and continuous filtration on the Boston water and economic sections of materials.

In closing I may add that the past year has been an unusually active one in all departments of the works.

Very respectfully yours,

(Signed)      DESMOND FITZ GERALD,  
*Resident Engineer.*

#### IN GENERAL.

The valley of Cold Spring brook below Dam 4 was surveyed for improving the water-course.

The lining of portions of the Beacon-street tunnel of the Sudbury aqueduct has been commenced, and is now in progress. The lining is of concrete, the inside ring being of Portland cement, and the backing of Rosendale cement.

[The illustrations indicate the method of doing this work. Plate No. 2 shows a section in course of preparation, the bottom is being pumped out between two temporary dams, and men are trying the sidewalls and roof, so as to detach any loose stone. Plate No. 3 shows the mixing-beds, the material being brought to them by cars, each having a capacity for carrying in separate compartments one cask of cement, two of sand, or five of broken stone. The materials are shovelled from the cars into the beds, then mixed and

shovelled into a car, by which it is transported to the work. Plate No. 4 shows the car of concrete in position for the building of the arch.]

During the season the study of animal and vegetable life in the water supply has received considerable attention. Early in the season Mr. Geo. W. Rafter, who had made a special study of this subject, was engaged, and later a biological laboratory was built, and a force engaged to continue the study.

The experiments on filtration have been continued through the greater part of the year, with the result that it has been determined to continue the experiments on a more elaborate scale. A plant for these experiments is now in preparation, and Mr. Hiram F. Mills, of Lawrence, a member of the Mass. State Board of Health, who has already made special studies of filtration, has been engaged as consulting engineer.

The pipe for a 24-inch high-service main, from the corner of Prince and Perkins streets to Forest Hills, has been contracted for, and will be laid the coming season. This main is a portion of the main pipe line that will connect the proposed reservoir in Roslindale with Fisher Hill reservoir, and it will be desirable to extend this main still further within a short time, in order to further improve the water supply for Roslindale and West Roxbury village.

Thirty-nine contracts for rock excavation have been made during the year.

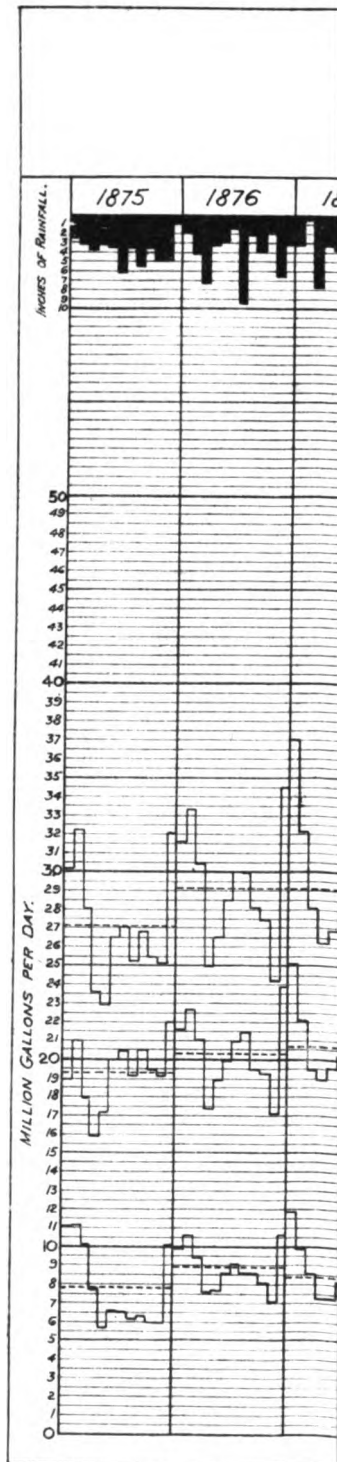
Two hundred and ninety petitions for main pipe extensions have been received and reported upon in regard to grade of streets, size of pipe, and cost of laying.

The pipe laid has been measured, the gates and hydrants located, and are being plotted on the plans.

Forty-seven profiles of unaccepted streets have been made and grades given for grading the streets and laying pipes wherever it was necessary.

The records from the four pumping stations, the lakes, reservoirs, the Mystic sewer, and the returns from the pipe foundries etc., have been carefully kept.





*Daily Average Consumption of Water, in Gallons, from the Cochituate and Mystic Works.*

COCHITUATE WORKS.												MYSTIC WORKS.											
MONTHS.	1933.	1934.	1935.	1936.	1937.	1938.	1939.	1933.	1934.	1935.	1936.	1937.	1938.	1939.	1933.	1934.	1935.	1936.	1937.	1938.	1939.		
January . . . .	34,715,500	32,162,300	26,711,900	28,561,900	32,687,600	40,485,700	30,172,000	8,369,600	8,019,100	7,855,400	8,510,300	10,488,600	11,107,100	7,769,500	8,369,600	8,019,100	7,855,400	8,510,300	10,488,600	11,107,100	7,769,500		
February . . . .	32,660,700	24,508,000	31,847,400	28,291,100	31,224,300	43,105,000	35,865,200	7,714,700	6,349,500	10,019,500	9,275,700	9,346,700	11,620,900	9,073,600	7,714,700	6,349,500	10,019,500	9,275,700	9,346,700	11,620,900	9,073,600		
March . . . . .	34,110,700	23,711,900	27,697,200	26,886,800	28,124,100	36,463,400	32,180,000	7,737,300	6,387,100	8,487,500	7,780,000	8,175,000	9,242,000	7,537,600	7,737,300	6,387,100	8,487,500	7,780,000	8,175,000	9,242,000	7,537,600		
April . . . . .	30,617,600	21,505,700	22,720,450	23,470,400	25,591,500	31,473,800	30,814,500	6,171,100	5,242,100	6,042,600	6,686,500	6,983,800	7,276,700	7,185,700	6,171,100	5,242,100	6,042,600	6,686,500	6,983,800	7,276,700	7,185,700		
May . . . . .	32,169,500	23,708,500	22,168,400	24,680,100	27,925,000	30,892,000	32,719,500	6,319,100	5,800,000	5,605,700	6,444,000	6,916,300	6,932,300	7,663,600	6,319,100	5,800,000	5,605,700	6,444,000	6,916,300	6,932,300	7,663,600		
June . . . . .	33,419,200	26,184,600	27,214,800	30,574,900	30,090,000	31,026,100	33,377,900	6,912,500	6,245,600	6,594,200	6,941,100	7,159,800	7,615,200	8,017,700	6,912,500	6,245,600	6,594,200	6,941,100	7,159,800	7,615,200	8,017,700		
July . . . . .	36,774,000	25,409,000	26,606,200	28,987,500	30,469,700	32,014,400	31,870,300	7,307,600	6,312,300	6,513,300	7,437,500	7,250,000	8,267,500	8,315,600	7,307,600	6,312,300	6,513,300	7,437,500	7,250,000	8,267,500	8,315,600		
August . . . . .	37,141,000	25,005,200	24,666,400	24,770,600	30,063,100	32,432,700	31,403,200	7,261,500	6,088,400	6,047,600	7,166,800	6,871,900	7,839,100	8,113,200	7,261,500	6,088,400	6,047,600	7,166,800	6,871,900	7,839,100	8,113,200		
September . . .	33,645,600	36,389,500	26,463,600	25,835,600	31,946,600	31,836,500	31,722,800	6,946,300	6,411,150	5,981,900	7,585,200	6,868,600	7,266,300	7,966,000	6,946,300	6,411,150	5,981,900	7,585,200	6,868,600	7,266,300	7,966,000		
October . . . . .	29,575,800	25,022,900	24,945,500	26,713,100	30,562,700	29,110,800	31,702,200	5,467,200	5,894,200	5,914,900	6,552,000	6,436,600	7,066,400	7,627,500	5,467,200	5,894,200	5,914,900	6,552,000	6,436,600	7,066,400	7,627,500		
November . . .	28,839,200	22,654,200	21,942,750	25,036,200	28,062,000	28,690,900	31,552,400	6,890,600	5,119,700	5,710,300	6,546,000	7,361,200	6,990,800	7,316,700	6,890,600	5,119,700	5,710,300	6,546,000	7,361,200	6,990,800	7,316,700		
December . . .	30,174,200	24,234,800	24,724,900	29,706,800	31,511,500	32,686,200	31,829,000	6,771,500	6,330,800	6,358,700	8,043,500	7,835,300	7,913,600	7,473,200	6,771,500	6,330,800	6,358,700	8,043,500	7,835,300	7,913,600	7,473,200		
Yearly average .	32,836,900	25,090,500	25,607,200	26,627,900	29,852,100	33,310,700	32,070,000	6,819,200	6,209,700	6,737,350	7,399,300	7,622,000	8,238,400	7,880,500	6,819,200	6,209,700	6,737,350	7,399,300	7,622,000	8,238,400	7,880,500		



*Diversion of Sudbury-River Water, 1881-89.*

Month.	1891.		1892.		1893.		1894.		1895.		1896.		1897.		1898.		1899.	
	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.
January . . . . .	814,800,000	565,000,000	565,000,000	565,000,000	723,400,000	697,000,000	473,900,000	509,200,000	602,200,000	895,400,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000
February . . . . .	680,300,000	975,700,000	975,700,000	975,700,000	597,800,000	285,400,000	540,400,000	380,800,000	472,000,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000	906,700,000
March . . . . .	853,600,000	1,002,300,000	1,002,300,000	1,002,300,000	634,700,000	312,600,000	486,900,000	467,400,000	456,700,000	691,400,000	691,400,000	691,400,000	691,400,000	691,400,000	691,400,000	691,400,000	691,400,000	691,400,000
April . . . . .	810,700,000	781,200,000	781,200,000	781,200,000	535,700,000	228,800,000	350,400,000	307,000,000	385,400,000	468,800,000	468,800,000	468,800,000	468,800,000	468,800,000	468,800,000	468,800,000	468,800,000	468,800,000
May . . . . .	960,100,000	502,300,000	502,300,000	502,300,000	613,800,000	268,400,000	306,500,000	344,700,000	444,200,000	566,200,000	566,200,000	566,200,000	566,200,000	566,200,000	566,200,000	566,200,000	566,200,000	566,200,000
June . . . . .	941,700,000	491,800,000	491,800,000	491,800,000	631,600,000	414,500,000	768,000,000	427,100,000	463,600,000	489,000,000	489,000,000	489,000,000	489,000,000	489,000,000	489,000,000	489,000,000	489,000,000	489,000,000
July . . . . .	911,200,000	646,900,000	646,900,000	646,900,000	754,300,000	152,000,000	434,600,000	534,500,000	397,500,000	528,900,000	528,900,000	528,900,000	528,900,000	528,900,000	528,900,000	528,900,000	528,900,000	528,900,000
August . . . . .	730,700,000	655,800,000	655,800,000	655,800,000	640,900,000	1,600,000	401,100,000	468,100,000	352,800,000	626,600,000	626,600,000	626,600,000	626,600,000	626,600,000	626,600,000	626,600,000	626,600,000	626,600,000
September . . . . .	731,500,000	308,900,000	308,900,000	308,900,000	467,100,000	442,200,000	386,100,000	414,700,000	577,300,000	581,600,000	581,600,000	581,600,000	581,600,000	581,600,000	581,600,000	581,600,000	581,600,000	581,600,000
October . . . . .	439,300,000	570,300,000	570,300,000	570,300,000	483,300,000	432,900,000	368,800,000	474,100,000	672,300,000	435,900,000	435,900,000	435,900,000	435,900,000	435,900,000	435,900,000	435,900,000	435,900,000	435,900,000
November . . . . .	321,700,000	572,300,000	572,300,000	572,300,000	580,800,000	363,900,000	297,600,000	381,800,000	607,100,000	410,900,000	410,900,000	410,900,000	410,900,000	410,900,000	410,900,000	410,900,000	410,900,000	410,900,000
December . . . . .	187,600,000	632,200,000	632,200,000	632,200,000	536,800,000	432,500,000	370,900,000	570,200,000	703,000,000	605,300,000	605,300,000	605,300,000	605,300,000	605,300,000	605,300,000	605,300,000	605,300,000	605,300,000
Totals . . . . .	187,600,000	8,657,700,000	7,735,200,000	1,245,100,000	7,209,900,000	1,416,300,000	4,694,300,000	5,224,700,000	6,124,100,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000
Total diversion from Sudbury river }	8,845,300,000	7,735,200,000	7,735,200,000	8,455,000,000	8,455,000,000	6,110,600,000	5,224,700,000	5,224,700,000	6,124,100,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000	7,224,700,000
Average daily diversion for whole year }	24,233,700	21,192,800	21,192,800	22,164,400	22,164,400	16,965,600	14,314,200	14,314,200	16,178,400	19,738,600	19,738,600	19,738,600	19,738,600	19,738,600	19,738,600	19,738,600	19,738,600	19,738,600

*Statement showing Amount of Water diverted from Sudbury River to Lake Cochituate and Chestnut-Hill Reservoir; Amount wasted; Amount of flow in River; Percentage of Rainfall collected, etc., 1875 to 1889.*

(Water-shed from 1875 to 1878, inclusive, = 77,764 sq. miles; in 1879 and 1880 = 78,238 sq. miles; and from 1881 to 1889, inclusive, = 76.2 sq. miles.)

YEAR.	Amount of Water diverted to Lake Cochituate and Chestnut-Hill Reservoir.	Amount of Water used by Framingham Water Co.	Amount of Water wasted from River.	STORAGE.		Total amount of flow in River.	Daily average amount of flow in River.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
	Gallons.	Gallons.	Gallons.	Gain.	Loss.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1875 . . . .	2,556,800,000	..	24,971,600,000	66,300,000	..	27,563,700,000	76,699,200	46.490	20.418	44.88
1876 . . . .	2,628,300,000	..	29,942,300,000	..	160,700,000	32,369,000,000	88,278,400	49.563	23.908	48.24
1877 . . . .	1,894,350,000	..	32,438,300,000	112,100,000	..	34,444,750,000	94,399,200	44.018	25.487	57.90
1878 . . . .	3,422,100,000	..	37,128,200,000	654,700,000	..	41,292,000,000	112,882,200	57.931	30.487	62.63
1879 . . . .	3,749,200,000	..	20,817,500,000	962,300,000	..	25,528,900,000	69,942,200	41.419	18.775	45.33
1880 . . . .	6,330,300,000	..	11,290,000,000	..	948,600,000	16,561,600,000	42,250,300	38.177	12.182	31.91
1881 . . . .	8,846,300,000	..	17,279,000,000	751,700,000	..	26,876,000,000	73,633,900	44.169	20.565	46.56
1882 . . . .	7,738,200,000	..	16,273,900,000	..	352,600,000	23,656,500,000	64,512,300	39.394	18.102	45.95
1883 . . . .	8,465,000,000	..	7,251,900,000	..	1,066,400,000	14,620,500,000	40,065,200	32.780	11.188	34.13
1884 . . . .	6,110,600,000	..	23,223,900,000	1,744,600,000	..	31,084,100,000	84,929,200	47.135	23.794	50.46
1885 . . . .	5,224,700,000	61,800,000	19,878,800,000	..	446,900,000	24,718,400,000	67,721,600	43.545	18.916	43.44
1886 . . . .	5,296,600,000	76,600,000	23,023,000,000	1,464,500,000	..	29,831,700,000	81,739,700	46.065	22.825	49.45
1887 . . . .	6,124,100,000	87,500,000	25,384,500,000	117,400,000	..	31,663,500,000	86,749,300	42.705	24.297	56.73
1888 . . . .	7,224,700,000	61,500,000	39,040,500,000	380,600,000	..	46,717,300,000	127,643,900	57.465	35.749	62.21
1889 . . . .	6,363,900,000	59,500,000	31,550,400,000	..	2,800,000	37,971,000,000	104,080,100	49.95	29.056	58.17
Averages .	5,445,736,700	69,360,000	23,908,063,300	..	..	29,651,900,000	80,970,200	45.390	22.378	48.54

*Statement showing Amount of Water drawn from Lake Cochituate; Amount wasted; Amount of Rainfall collected in Lake; Amount received into Lake from Sudbury River; Percentage of Rainfall collected, etc., 1852 to 1889; Water-shed of Lake, 12,077 Acres.*

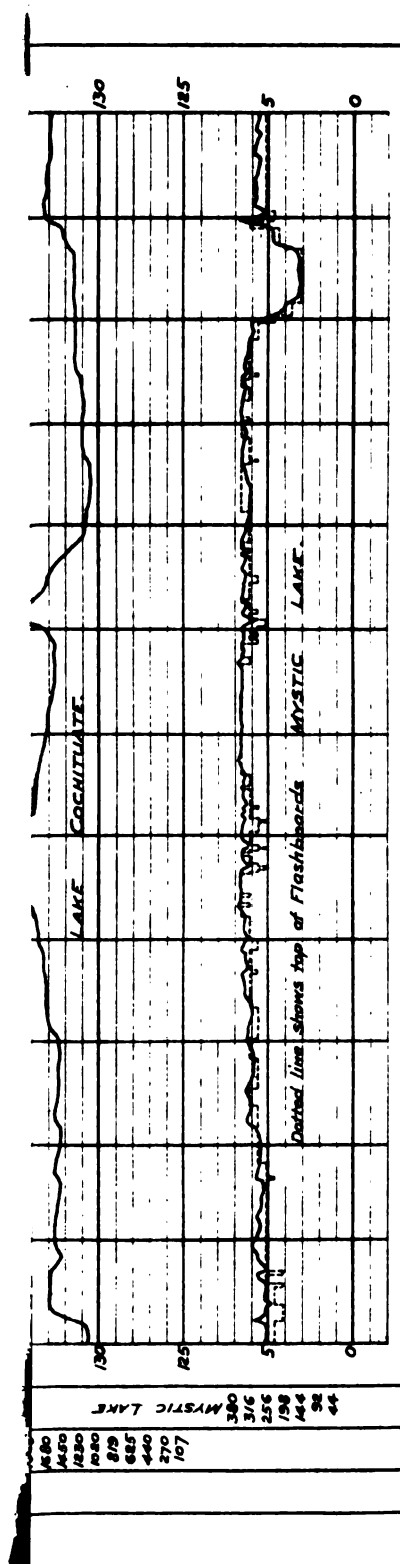
YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Amount received into Lake from Sudbury River.	STORAGE.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1852 <sup>1</sup> .	2,974,042,800	4,020,566,900	.....	.....	261,840,000	6,733,949,700	18,396,900	47.93	20.61	43.
1853	3,117,935,500	3,166,417,500	.....	239,580,000	.....	6,523,937,000	17,873,800	55.73	19.51	35.
1854	3,614,230,000	4,187,733,000	.....	.....	217,800,000	7,584,168,000	20,778,500	43.15	22.87	53.
1855	3,776,399,500	No account kept	.....	.....	826,700,000	.....	.....	34.96	.....	.....
1856	4,409,787,600	"	.....	598,950,000	.....	.....	.....	40.80	.....	.....
1857	4,644,990,000	10,625,900,000	.....	32,670,000	.....	15,303,560,000	41,927,800	63.10	46.69	74.
1858	4,689,155,000	1,934,500,000	.....	.....	141,570,000	6,492,085,000	17,759,000	48.66	19.46	40.
1859 <sup>2</sup> .	4,808,875,000	7,569,000,000	.....	283,140,000	.....	12,661,015,000	34,687,700	49.02	38.24	78.
1860	6,309,108,000	None.	.....	174,240,000	.....	6,483,348,000	17,714,100	55.44	19.40	35.
1861	3,277,559,000	3,277,559,000	.....	.....	1,459,260,000	8,537,394,900	23,444,900	45.44	25.45	56.
1862	6,059,000,000	83,200,000	.....	1,308,800,000	.....	7,399,000,000	20,271,200	49.69	22.36	45.
1863	5,927,052,500	2,165,698,500	.....	762,300,000	.....	8,555,049,000	24,290,400	69.30	29.88	39.
1864	6,105,306,700	1,368,746,000	.....	.....	1,848,577,000	5,625,475,700	15,370,200	42.60	18.35	43.
1865	4,621,630,000	1,688,120,700	.....	748,212,500	.....	7,051,968,200	19,323,300	49.46	20.50	41.
1866	4,463,556,000	None.	.....	743,242,500	.....	5,209,827,500	14,265,300	62.32	16.01	28.
1867	4,951,225,000	2,462,041,000	.....	.....	698,811,000	6,734,455,000	18,450,900	56.25	21.80	39.

1868	5,405,515,000	2,607,684,000	.....	346,371,000	.....	8,259,570,000	22,567,200	49.71	24.98	50.
1869	5,603,751,000	1,635,570,000	.....	480,882,000	.....	7,620,203,000	20,877,200	64.84	21.99	34.
1870	5,477,810,000	4,818,971,000	.....	.....	.....	8,660,696,000	23,453,300	55.89	26.08	47.
1871	5,228,500,000	None.	.....	.....	.....	250,933,000	13,623,500	45.39	15.16	33.
1872	5,775,151,200	None.	.....	.....	.....	.....	16,416,000	48.47	17.22	35.
1873	6,511,324,900	2,917,977,000	.....	1,543,995,500	.....	8,914,671,900	24,423,300	46.48	27.13	60.
1874	6,632,972,900	1,146,851,700	.....	.....	.....	6,402,109,600	17,540,000	35.98	19.52	54.
1875	7,092,965,500	None.	.....	1,222,885,000	.....	5,760,040,500	15,780,900	45.49	17.57	38.
1876	7,277,176,200	1,619,243,800	.....	2,528,300,000	.....	6,411,557,000	17,517,900	48.49	19.54	40.
1877	7,628,889,200	1,454,978,600	.....	378,727,000	.....	7,596,244,800	20,811,900	45.80	23.17	53.
1878	7,745,904,700	3,841,876,000	.....	2,663,300,000	.....	8,387,293,700	23,653,700	53.55	26.34	49.
1879	6,051,838,900	1,593,351,400	.....	411,300,000	.....	5,941,203,000	16,003,300	38.01	17.81	47.
1880	4,284,147,100	65,577,700	.....	826,700,000	.....	3,576,759,800	9,236,100	35.83	10.30	29.
1881	2,846,459,700	2,231,016,700	.....	187,600,000	.....	5,357,965,800	14,679,400	41.09	16.34	40.
1882	3,985,400,600	1,358,543,700	.....	408,089,400	.....	4,536,999,600	13,625,200	40.29	15.05	37.
1883	4,731,227,700	162,351,800	.....	.....	.....	3,514,099,500	9,079,700	31.20	10.11	32.
1884	4,583,154,450	1,842,837,100	.....	1,340,435,700	.....	6,300,130,250	17,213,450	45.57	19.21	42.
1885	4,091,674,900	1,006,622,800	.....	8,594,800	.....	5,106,892,500	13,991,500	43.66	15.57	34.
1886	4,432,536,100	8,116,283,200	.....	.....	.....	7,188,157,300	19,663,600	46.97	21.92	47.
1887	4,802,120,700	3,658,652,900	.....	.....	.....	7,997,568,600	21,089,200	41.58	23.47	56.
1888	4,968,503,100	4,229,300,000	.....	969,309,000	.....	10,157,012,100	27,751,400	56.83	30.97	54.
1889	5,570,433,600	3,373,929,000	.....	454,766,800	.....	9,165,719,400	25,111,600	50.23	27.95	55.
Averages	5,200,564,600	2,351,667,200	.....	.....	.....	7,178,338,300	19,854,600	47.94	21.82	45.

1 Observation of rainfall at Lake Cochituate commenced 1862, and these observations are assumed as correct for the whole district.  
 2 Lake raised two feet.

*Table showing the Average Monthly and Yearly Heights above Tide-marsh Level of the Water in the Lakes and Reservoirs of the Boston Water-Works.*

MONTHS.	Reservoir No. 1. Flash boards, 169.29.	Reservoir No. 2. Flash boards, 167.12.	Reservoir No. 3. Stone crest, 175.24.	Reservoir No. 4. Flash boards, 215.21.	Farm Pond. High water, 149.25.	Lake Cochituate, High water, 134.36.	Chestnut-Hill Reservoir, High water, 124.00.	Brookline Reservoir, High water, 124.00.	Parker-Hill Reservoir, High water, 219.00.	Mystic Lake, High water, 7.00	Mystic Reservoir, High water, 147.00.	Fisher-Hill Reservoir, High water, 241.00.											
	1888.	1889.	1888.	1889.	1888.	1889.	1888.	1889.	1888.	1889.	1888.	1889.											
January . .	157.80	158.24	165.86	166.35	175.39	175.62	210.46	214.09	149.27	149.43	125.97	132.31	123.59	123.66	123.22	123.46	219.00	5.31	5.41	146.88	146.72	239.42	239.71
February .	158.00	157.92	166.22	166.12	173.19	175.43	212.63	214.54	149.29	149.72	126.40	132.51	123.65	123.61	123.28	123.37	219.00	5.22	5.53	146.95	146.84	239.20	239.64
March . . .	158.22	157.94	165.29	166.13	172.94	175.52	213.83	214.51	149.27	149.37	126.35	132.44	123.73	123.84	123.43	123.64	219.00	5.22	6.03	146.89	146.75	239.55	239.71
April . . .	158.23	157.97	166.21	166.55	175.55	175.58	214.85	214.52	149.25	149.35	130.60	133.19	123.81	123.85	123.56	123.67	219.00	5.86	6.31	146.76	146.69	239.42	239.76
May . . .	158.01	158.24	166.17	166.52	175.51	175.51	215.07	214.71	149.28	149.37	130.14	134.09	123.55	123.82	123.20	123.40	219.00	6.51	6.59	146.81	146.64	239.31	239.73
June . . .	158.39	158.88	166.81	166.01	175.13	175.47	215.13	214.76	149.25	149.45	129.09	133.71	123.82	123.75	123.64	123.56	219.00	6.61	6.58	146.54	146.56	239.46	239.44
July . . .	158.92	159.39	164.26	163.52	174.45	175.43	215.11	215.01	149.26	149.36	127.31	132.85	123.76	123.91	123.57	123.72	217.62	5.78	6.63	146.47	146.71	239.20	240.14
August . .	158.91	158.65	162.45	167.27	174.27	175.60	212.50	215.01	149.28	149.55	126.20	132.73	133.73	123.63	123.53	123.44	217.95	4.79	6.43	145.60	146.70	238.40	239.90
September,	159.29	157.81	164.26	167.04	175.43	175.34	212.80	215.09	148.31	149.41	126.42	130.75	123.75	123.56	123.57	123.35	218.15	5.11	6.32	144.83	146.59	239.08	239.65
October . .	157.52	158.00	167.41	164.50	175.69	175.41	215.20	214.77	148.19	149.50	127.91	131.23	123.43	123.54	123.27	123.35	218.09	6.22	6.31	146.42	146.60	239.77	240.41
November .	157.05	158.01	167.38	162.70	175.58	175.54	215.02	214.57	149.27	149.36	127.89	131.77	123.51	123.50	123.36	123.32	217.81	5.82	4.01	146.61	146.79	239.68	240.01
December .	157.30	158.17	166.52	166.27	175.59	175.70	214.57	214.66	149.42	149.46	130.30	132.99	123.41	123.58	123.22	123.37	218.09	5.28	5.66	146.68	146.69	239.46	240.31
Yearly averages }	158.14	158.27	166.74	165.75	174.89	175.51	213.96	214.74	149.11	149.44	128.13	132.55	123.65	123.69	123.40	123.47	218.48	5.64	5.98	146.45	146.69	239.33	239.87





*Statement showing Amount of Water drawn from Mystic Lake; Amount wasted; Amount of Rainfall collected in Lake; Percentage of Rainfall collected, etc., 1876 to 1889; Water-shed of Lake, 17,200 Acres.*

YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	STORAGE.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
			Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1876 . . . . .	3,280,101,300	6,866,774,700	. . . . .	32,583,000	9,667,288,000	26,140,100	47.00	20.49	43.6
1877 . . . . .	3,086,664,800	7,260,228,500	. . . . .	16,291,400	10,808,486,900	28,228,700	43.096	22.06	51.2
1878 . . . . .	3,387,460,400	8,718,647,600	. . . . .	26,000,000	12,090,088,000	33,041,200	54.068	25.82	47.8
1879 . . . . .	3,490,848,200	4,625,991,800	. . . . .	208,000,000	7,913,640,000	21,680,900	38.30	16.94	48.0
1880 . . . . .	3,692,196,700	2,168,761,200	. . . . .	113,500,000	6,708,766,900	16,684,000	34.42	12.21	36.5
1881 . . . . .	2,616,879,900	5,684,300,000	371,200,000	. . . . .	8,721,079,900	28,868,400	41.91	18.67	44.5
1882 . . . . .	2,670,896,700	4,444,668,000	16,000,000	. . . . .	7,030,664,700	19,281,800	36.165	16.06	38.4
1883 . . . . .	2,664,614,900	2,084,702,600	. . . . .	347,579,000	4,351,637,900	11,922,300	31.22	9.83	29.84
1884 . . . . .	2,466,761,000	6,674,008,800	380,600,000	. . . . .	9,424,364,800	26,749,600	44.39	20.18	46.46
1885 . . . . .	2,638,378,800	6,688,860,600	. . . . .	33,200,000	8,194,639,300	22,451,900	44.50	17.56	39.43
1886 . . . . .	2,862,947,600	7,745,238,900	. . . . .	28,400,000	10,577,806,400	28,960,300	46.56	22.65	46.71
1887 . . . . .	2,964,257,600	7,414,213,000	. . . . .	11,000,000	10,357,470,600	28,376,600	46.42	22.17	47.77
1888 . . . . .	3,206,121,100	11,384,668,100	. . . . .	6,000,000	14,683,714,200	39,709,600	56.745	31.12	54.84
1889 . . . . .	3,007,639,800	8,679,787,600	12,000,000	. . . . .	11,869,337,300	32,600,900	50.395	25.48	50.56
Averages . . . . .	3,002,863,360	6,333,670,400			9,331,358,560	25,544,400	43.87	19.98	44.76



*Statement of Operations at the Chestnut-Hill Pumping-Station for 1889.*

1889.	Engine No. 1.		Engine No. 2.		Total amount pumped.	Gallons.	Daily average pumped.	Total amount of coal consumed.	Lbs.	Daily average amount of coal consumed.	Total ashes and cinders.	Per cent. ashes.	Quantity pumped per lb. of coal.	Gallons.	Corrected for heating and lighting.	Average lbs in feet.	Duty in ft.-lbs. per 100 lbs. of coal.			Water evaporated in Boilers per lb. of coal.
	Hrs.	Min.	Hrs.	Min.													Gallons.	Amount pumped.	Lbs.	
					Total pump- ing time.	Amount pumped.	Total pump- ing time.	Amount pumped.												
Months.	Hrs.	Min.	Gallons.	Hrs.	Min.	Gallons.	Gallons.	Lbs.	Lbs.	Lbs.	Lbs.	Per cent.	Quantity pumped per lb. of coal.	Gallons.	Corrected for heating and lighting.	Average lbs in feet.	Without correction for heating and lighting.	Corrected for heating and lighting.	Corrected for heating and lighting.	
January	373	10	120,360,000	162	10	53,757,850	174,117,850	6,515,700	214,706	6,926	16,047	7.5	811.0	873.4	123.78	83,041,400	89,435,600	89,435,600	9.47	11.93
February	510	15	170,303,500				170,303,500	6,082,300	198,564	7,062	14,428	7.3	857.7	933.2	123.28	88,182,400	95,942,500	95,942,500	9.72	11.52
March	425		144,635,250	101	45	32,656,500	177,191,750	6,715,900	209,946	6,772	16,193	7.2	844.0	904.8	123.48	86,915,800	93,173,700	93,173,700	9.51	11.31
April				511	50	162,530,250	162,530,250	6,417,700	189,852	6,328	13,517	7.1	856.1	898.0	122.92	87,762,200	92,062,500	92,062,500	9.67	11.52
May					571	15	183,062,250	183,062,250	196,913	6,352	14,900	7.6	929.7	929.7	122.72	95,149,300	95,149,300	95,149,300	9.66	11.26
June	209	50	70,832,750	349	55	113,940,750	183,873,500	6,129,100	195,862	6,539	14,702	7.5	938.8	946.4	122.35	95,794,200	95,794,200	96,464,800	9.75	11.30
July	563		187,811,750				187,811,750	6,068,400	207,285	6,696	15,309	7.4	906.1	946.1	122.46	92,545,900	92,545,900	96,525,400	9.85	11.36
August	551	30	188,040,100				188,040,100	6,065,800	212,773	6,864	16,040	7.4	883.8	925.3	122.87	90,562,000	90,562,000	94,818,400	9.71	11.22
September,	545		189,435,725				189,435,725	6,314,500	214,604	7,153	16,309	8.5	882.7	931.2	123.15	90,661,900	91,296,500	95,678,700	9.70	11.26
October					534		182,896,575	5,899,900	212,419	6,852	17,847	8.4	861.0	960.9	124.06	86,085,600	93,361,700	99,430,200	10.25	11.90
November,					489	50	169,846,250	6,661,500	201,672	6,722	17,945	8.9	842.2	951.7	124.27	87,235,600	91,911,700	98,621,300	9.96	11.61
December.	438	15	152,121,470	65		22,695,925	174,817,395	6,639,300	208,176	6,715	19,233	9.2	839.8	953.2	124.18	86,970,400	91,927,700	98,730,300	10.13	11.88
Totals and averages,	3616		1,223,540,545	2785	45	920,385,250	2,143,925,795	5,573,800	2,462,751	6,747	193,490	7.9	870.5	923.8	123.21	86,454,300	92,719,400	95,445,400	9.78	11.44

# REPORT OF CITY ENGINEER.

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## Statement of Operations at the Mystic Pumping-Station for 1889.

1889.	ENGINE NO. 1.				ENGINE NO. 2.				ENGINE NO. 3.				Total amount pumped.	Gallons.	Daily average amount pumped.	Gallons.	Lbs.	Daily average amount consumed.	Lbs.	Daily average amount ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per lb. of coal.	Average lift in feet.	Duty in foot-pounds per 100 lbs. of total coal.
	Total pumping time.		Amount pumped.	Gallons.	Total pumping time.		Amount pumped.	Gallons.	Total pumping time.		Amount pumped.	Gallons.												
	Hrs.	Mins.			Hrs.	Mins.			Hrs.	Mins.														
Month.	Hrs.	Mins.	Gallons.	Hrs.	Mins.	Gallons.	Hrs.	Mins.	Gallons.	Hrs.	Mins.	Gallons.	Hrs.	Mins.	Gallons.	Lbs.	Lbs.	Per ct.	Gal.	Feet.	Fl. lbs.			
January . . . . .																								
February . . . . .	8		2,008,300	215	45	40,317,000																		
March . . . . .				30	15	6,024,900																		
April . . . . .																								
May . . . . .																								
June . . . . .																								
July . . . . .																								
August . . . . .		45	211,400	68	15	12,517,900																		
September . . . . .	6	45	1,253,300	41		8,395,600																		
October . . . . .	100	45	16,443,900	177	45	34,971,000																		
November . . . . .	308	30	55,266,000	484	45	91,173,800																		
December . . . . .																								
Totals and Averages	424	45	76,182,900	1,224	30	233,123,900																		

*Rainfall in Inches and Hundredths on the Sudbury-river Water-shed for the Year 1889.*

1889.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. . . . .		0.02		0.81				0.88		0.42		
2. . . . .						0.975						
3. . . . .				0.02				0.17			0.35	0.13
4. . . . .						0.605	1.495			0.01		
5. . . . .		0.32				0.34		0.50				0.155
6. . . . .			1.125									
7. . . . .	2.75						0.08			1.215		
8. . . . .						0.115						
9. . . . .	0.56	0.095						0.435				0.725
10. . . . .					0.145	0.10				0.065	0.325	
11. . . . .						0.06	0.22				0.08	0.225
12. . . . .		0.29		0.085					1.125			
13. . . . .				0.165	0.05					1.27	0.25	
14. . . . .									0.875	0.19		0.475
15. . . . .						0.145	1.515	2.095				
16. . . . .		0.475										
17. . . . .	0.655					0.435						
18. . . . .		0.41	0.48	0.51								
19. . . . .									1.64			0.70
20. . . . .				0.185			1.025				1.49	
21. . . . .	0.54			0.095	1.74				0.48	0.07		
22. . . . .											0.52	0.255
23. . . . .							0.535					
24. . . . .	0.01							0.145				0.37
25. . . . .					0.225							
26. . . . .				0.04	0.275				0.285	0.035		0.04
27. . . . .	0.855	0.045		1.55	0.51	0.025	2.03			0.82		
28. . . . .			0.125								3.175	
29. . . . .							0.185					0.065
30. . . . .			0.035				1.00		0.25			
31. . . . .			0.60				0.905			0.17		
Totals . .	5.37	1.655	2.365	3.41	2.945	2.80	8.94	4.175	4.605	4.255	6.29	3.14

Total rainfall during the year, 49.95 inches.  
Being an average of two gauges, located at Framingham and Westboro'.

*Rainfall in Inches and Hundredths on Lake Cochituate Water-shed for the Year 1889.*

1889.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. ....	...	...	...	0.90	...	...	...	1.55	...	0.10	...	...
2. ....	...	...	...	...	...	1.35	...	...	...	...	...	...
3. ....	...	0.02	...	0.08	...	...	...	0.06	...	...	0.42	0.10
4. ....	...	...	...	...	...	0.65	1.58	...	...	...	...	...
5. ....	...	0.25	...	...	...	0.16	...	0.27	...	...	...	0.11
6. ....	...	...	0.96	...	...	...	...	...	...	...	...	...
7. ....	2.57	...	...	...	...	...	0.01	...	...	1.33	...	...
8. ....	...	...	...	...	...	0.17	...	...	...	...	...	...
9. ....	0.50	0.13	...	...	...	...	...	0.82	...	...	...	0.60
10. ....	...	...	...	...	0.10	0.05	...	0.28	...	...	0.31	...
11. ....	...	...	...	...	...	0.08	0.16	...	...	...	0.08	0.18
12. ....	...	0.28	...	0.01	...	...	...	...	1.50	...	...	...
13. ....	...	...	...	0.11	0.10	...	...	...	...	...	0.35	...
14. ....	...	...	...	...	...	...	...	...	0.80	1.61	...	0.24
15. ....	...	...	...	...	...	0.30	1.50	1.92	0.18	...	...	...
16. ....	...	0.40	...	...	...	...	...	...	...	...	...	...
17. ....	0.59	...	...	...	...	0.46	...	...	...	...	...	...
18. ....	...	0.46	0.52	0.56	...	...	...	...	...	...	...	0.69
19. ....	...	...	...	...	...	...	...	...	1.78	...	...	...
20. ....	...	...	...	0.15	...	...	1.28	...	0.16	...	1.54	0.01
21. ....	1.10	...	...	0.15	2.25	...	...	...	0.07	0.06	...	...
22. ....	...	...	...	...	...	...	...	...	...	...	0.51	0.27
23. ....	...	...	...	...	...	...	0.09	...	...	...	...	...
24. ....	...	...	...	...	...	...	0.03	0.17	...	...	...	0.37
25. ....	...	...	...	...	0.21	...	...	...	...	...	...	...
26. ....	...	...	...	...	0.33	...	...	...	0.24	...	...	0.02
27. ....	0.70	0.02	...	1.28	0.62	...	2.20	...	...	0.55	...	...
28. ....	...	...	0.13	...	...	...	...	...	...	...	2.63	...
29. ....	...	...	...	...	...	...	...	...	...	0.04	...	0.11
30. ....	...	...	0.04	...	0.02	...	...	...	0.19	...	...	...
31. ....	...	...	0.63	...	0.01	...	2.25	...	...	0.16	...	...
Totals. .	5.46	1.56	2.28	3.19	3.64	3.17	9.10	4.57	4.92	3.85	5.79	2.70

Total rainfall during the year, 50.23 inches.

*Rainfall in Inches and Hundreds on the Mystic Lake Water-shed for the Year 1889.*

1889.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. . . . .		0.01		0.856				0.806		0.11		
2. . . . .						1.465						
3. . . . .				0.075				0.155			0.475	0.09
4. . . . .						0.31	1.155			0.015		
5. . . . .		0.43				0.33		0.135				0.155
6. . . . .			1.06									
7. . . . .	3.215									0.70		
8. . . . .						0.27						
9. . . . .	0.395	0.13						0.395				0.645
10. . . . .					0.06	0.11	0.01			0.015	0.24	
11. . . . .						0.06	0.06				0.04	0.22
12. . . . .		0.39		0.03					1.075			
13. . . . .				0.22	0.065					1.205	0.255	
14. . . . .								2.215	0.76	0.31		0.23
15. . . . .					0.01	0.29	0.895		0.045			
16. . . . .		0.405										
17. . . . .	0.57					0.355	0.08					
18. . . . .		0.47	0.435	0.55								
19. . . . .									1.91			0.705
20. . . . .			0.01	0.18			1.505				1.89	
21. . . . .	0.63			0.03	3.075				0.395	0.075		
22. . . . .											0.435	0.24
23. . . . .							0.12			0.015		
24. . . . .								0.215				0.46
25. . . . .				0.01	0.275							
26. . . . .					0.375				0.28			0.04
27. . . . .	0.695	0.025		1.645	0.685	0.05	2.405			0.835		
28. . . . .			0.165								2.315	
29. . . . .				0.015		0.075	0.625			0.16		0.075
30. . . . .			0.015		0.065				0.24			
31. . . . .			0.60		0.03		1.61			0.25		
Totals . .	5.505	1.86	2.285	3.61	4.64	3.315	8.455	3.92	4.705	3.59	5.66	2.86

Total rainfall during the year, 50.395 inches.

*Monthly Rainfall in Inches, during 1889, at Various Places in Eastern Massachusetts.*

PLACE.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lake Cochituate . . . . .	5.46	1.56	2.28	3.19	3.64	3.17	9.10	4.57	4.92	3.85	5.79	2.70	50.23
Framingham . . . . .	5.36	1.68	2.46	3.59	4.05	3.42	9.34	4.49	4.61	4.65	6.28	3.15	53.08
Westborough . . . . .	5.38	1.63	2.27	3.23	1.84	2.18	8.54	3.86	4.60	3.86	6.30	3.13	46.82
Chestnut Hill . . . . .	6.50	1.93	2.87	3.82	4.78	3.31	9.53	4.51	5.30	3.85	6.23	2.66	54.79
Mystic Station . . . . .	5.13	1.82	2.21	3.59	4.56	3.27	8.10	4.18	4.61	3.47	5.06	2.80	48.80
Mystic Lake . . . . .	5.88	1.90	2.36	3.63	4.72	3.36	8.31	3.66	4.80	3.71	6.24	2.92	51.99
Mystic Engine-House . . . . .	5.57	1.80	2.25	3.65	4.64	3.43	8.58	3.62	4.86	3.88	5.88	2.83	50.99
Boston Pipe Yard . . . . .	6.18	2.00	2.42	3.98	4.93	4.18	8.44	4.46	4.28	4.19	5.83	2.36	53.25
Cambridge Observatory . . . . .	6.01	1.44	1.05	2.54	5.39	2.53	6.42	4.42	4.30	3.65	4.97	2.12	44.84
Waltham, Boston Manufacturing Co. . . . .	6.24	1.53	2.03	4.35	5.35	3.29	9.90	3.50	4.26	3.62	6.08	2.96	53.11
Lowell, Locks and Canals Co. . . . .	5.037	1.710	1.988	3.630	3.890	2.592	6.102	3.979	3.266	4.268	6.929	3.368	46.756
Lowell-Merriman Manufacturing Co. . . . .	4.74	1.72	1.95	2.16	3.14	2.36	6.23	3.18	3.30	4.42	6.28	2.06	41.43
Average of twelve places . . . . .	5.624	1.727	2.186	3.447	4.244	3.091	8.287	4.086	4.417	3.561	5.989	2.755	49.874

*Rainfall Received and Collected, 1889.*

MONTHS.	SUDBURY.			COCHITUATE.			MYSTIC.		
	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.
	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.
January . .	5.37	4.963	92.42	5.46	4.50	82.45	5.505	4.51	81.84
February . .	1.655	1.926	116.39	1.56	1.85	118.67	1.86	1.83	98.34
March . . .	2.365	2.388	100.95	2.28	2.08	91.48	2.285	1.60	70.18
April . . .	8.41	2.434	71.37	3.19	2.17	68.10	3.61	2.27	62.97
May . . . .	2.945	1.569	53.27	3.64	1.20	32.87	4.64	2.18	46.90
June . . . .	2.80	1.128	40.27	3.17	1.18	37.13	3.315	1.89	56.97
July . . . .	3.94	1.130	12.64	9.10	1.63	17.90	3.455	1.33	15.79
August . .	4.175	2.554	61.18	4.57	3.43	74.99	3.92	2.05	52.30
September .	4.605	1.422	30.87	4.92	1.79	36.38	4.705	1.06	22.51
October . .	4.255	2.194	51.57	3.85	1.91	49.57	3.59	1.21	33.73
November .	6.29	3.351	53.27	5.79	2.95	50.91	5.65	2.49	44.09
December .	3.14	3.997	127.30	2.70	3.26	120.65	2.86	3.06	107.02
Totals and averages )	49.96	29.056	58.17	50.23	27.95	55.64	50.395	25.48	50.56

*Table showing the Temperature of Air and Water at Various Stations on the Water-Works.*

1889.	TEMPERATURE OF AIR.						TEMPERATURE OF WATER.	
	Chestnut-Hill Reservoir.			Frammingham.			Brookline Reservoir.	Mystic Engine-house.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Mean.	Mean.
January . . .	58.0	6.5	33.0	58.0	5.0	32.6	37.0	36.6
February . . .	47.0	-4.0	25.0	48.0	-5.0	24.2	36.9	36.3
March . . . .	63.5	19.0	37.0	62.0	18.0	37.3	38.5	36.5
April . . . . .	80.0	28.0	47.5	79.0	26.0	48.0	47.2	45.3
May . . . . .	91.5	37.0	60.6	93.0	36.0	61.1	60.6	63.2
June . . . . .	88.0	45.0	68.4	90.0	45.0	69.0	67.6	68.7
July . . . . .	89.0	50.5	69.7	88.0	50.0	70.3	72.7	74.6
August . . . .	86.0	46.0	67.0	84.0	45.0	66.8	71.0	72.9
September . .	85.0	38.0	63.1	83.0	37.0	62.4	66.8	68.3
October . . . .	75.0	27.0	47.9	72.0	26.0	47.6	54.5	54.8
November . . .	65.5	17.0	43.1	65.0	17.0	43.3	46.8	47.0
December . . .	64.0	8.0	36.3	64.0	6.0	36.8	39.0	39.8



## C. — IMPROVED SEWERAGE.

The following is a statement of the condition of the appropriation for Improved Sewerage Construction to Jan. 1, 1890 :—

Total appropriations . . . . .	\$5,913,089 93
Expended to Jan. 1, 1890 . . . . .	5,419,251 74
	<hr/>
Balance Jan. 1, 1890 . . . . .	\$493,838 19

By an act of Legislature, entitled "An Act to enable the City of Boston to extend its Improved Sewerage System," approved May 9, 1889, the Board of Aldermen was authorized to extend the construction of the Improved Sewerage System, and to take land therefor; also to incur indebtedness to an amount not exceeding \$500,000 outside of the limit of indebtedness fixed by law for the city.

On May 29, 1889, an order of the Board of Aldermen was approved, "That the City Engineer is hereby directed to proceed with surveys of the extension of the Improved Sewerage System to Dorchester Lower Mills and Brighton, the expense thereof to be charged to the available balance of the loan for Improved Sewerage Construction."

In accordance with this order an engineering force was at once organized and surveys and investigations commenced.

On Sept. 30, 1889, these surveys having progressed sufficiently to indicate the general method to be pursued in regard to the extension of the Improved Sewerage System, a plan was submitted to the Board of Aldermen, and the following order was passed :—

"*Whereas*, it is hereby adjudged to be necessary for the public convenience and the public health of the City of Boston to continue and extend the Improved Sewerage System, as shown on the plan hereinafter mentioned, it is therefore

"*Ordered*, That intercepting sewers, in continuance and extension of the Improved Sewerage System of the City of Boston, be laid and constructed in the streets and places substantially as shown and indicated by red lines and dotted red lines on a plan dated Sept. 23, 1889, and marked 'Main and branch intercepting sewers and proposed extension of same,' on file in the office of the City Engineer.

"That the City Engineer be and he is hereby directed to lay and construct the same, and that the expense thereof be charged to the appropriation for Improved Sewerage."

This order was passed on Sept. 30 and approved on Oct. 2, 1889; the loan of \$500,000 having been passed on Sept. 3 and approved Sept. 14, 1889.

The surveys and investigations being well advanced, and plans and specifications having been prepared for several of the sections of sewer, proposals were advertised for the construction of the same, and contracts were awarded on Oct. 15, 1889, to the lowest bidders, on the following sewers:—

*Section 8.*—South Boston Intercepting Sewer.

*Section 9.*—South Boston Intercepting Sewer.

*Section 3.*—Dorchester Intercepting Sewer.

*Section 1.*—Brighton Intercepting Sewer.

Owing to the open winter, work is well advanced on the above sewers, with the exception of the Brighton sewer.

The result of the surveys, the work now in progress, and the work proposed to be done, is as follows:—

#### CITY PROPER.

The extension of the Improved Sewerage System in the city proper will require—

*First.* The building of an intercepting sewer in Commercial street, from the end of the present "West Side Intercepting Sewer" at Prince street to Charter street. This sewer, to be known as "Section 7, West Side Intercepting Sewer," will be about 500 feet long, and will intercept the sewage now flowing into the docks at the foot of Hull and Charter streets.

The construction of this sewer will complete the "West Side Intercepting Sewer."

*Second.* The building of an intercepting sewer in Atlantic avenue, from Central street to Commercial street, and in Commercial street, from Atlantic avenue to Hanover street. These sewers will be known as "Sections 5 and 6, East Side Intercepting Sewer," and will be 1,525 and 1,575 feet long, respectively. These sewers will intercept sewage now emptying into the docks at the foot of Clark, Battery, and Hanover streets.

The construction of these sewers will complete the East Side Intercepting Sewer, and together with the construction of Section 7, West Side Intercepting Sewer, previously mentioned, will remove all sewage now emptying along the water-front of the North End.

*Third.* The first section of the intercepting sewer, which will ultimately extend up the Charles-river valley and sewer

Brighton, Newton, Watertown, and Waltham, is located in Huntington avenue, and extends from Gainsboro' street (where it joins the main intercepting sewer) to Parker street.

This Charles-river valley sewer will be built by the State, under the direction of the Metropolitan Sewerage Commissioners. The drainage of a large territory in Roxbury now overflows into the Back Bay park, and in order to do away with this nuisance, it is proposed that the city of Boston shall build the first section of this sewer, so as to intercept the sewage now emptying into the park.

This sewer will be completed in October, 1890, and will complete the extension of intercepting sewers in the city proper.

### SOUTH BOSTON.

The extension of the Improved Sewerage System in South Boston will require —

*First.* The building of intercepting sewers in First street and East Second street, from D street to L street.

These sewers, to be known as "Sections 8 and 9, South Boston Intercepting Sewers," will be 2,363 and 1,877 feet long, respectively; they will intercept sewage now emptying into the docks at the foot of F, I, and L streets.

Plans and specifications for these sewers were completed in October, 1889, and proposals for their construction advertised for.

Section 8, South Boston intercepting sewer, was awarded to the Metropolitan Construction Company, for the estimated sum of \$21,332.95, they being the lowest bidder.

Work has rapidly progressed on this section, and its completion is expected in May, 1890.

Section 9, South Boston intercepting sewer, was awarded to Collins & Ham, for the estimated sum of \$13,832.95, this firm being the lowest bidder.

Good progress has been made on the construction of this sewer, which will be finished in May, 1890.

The construction of these sewers will complete the extension of the Improved Sewerage System along the north side of South Boston, and will intercept all sewage now emptying along this water-front.

*Second.* The building of an intercepting sewer from Sixth street to East First street, through the Marine park and O street, to intercept sewage now emptying at East First street.

This sewer will be about 2,200 feet long.

Surveys have been made for the construction of this

sewer, and the work will be completed during the coming season.

The construction of this sewer, together with Sections 8 and 9, previously mentioned, will complete the extension of the Improved Sewerage System in South Boston, until further extensions are required by the filling of the flats to the line established by the Harbor and Land Commissioners.

#### DORCHESTER.

The extension of the present Dorchester intercepting sewer to Dorchester Lower Mills will require the construction of about four miles of sewers.

Plans and specifications were completed for part of this sewer, and the first section has been put under contract to Mr. A. A. Hall, for the estimated sum of \$28,731.40, he being the lowest bidder.

Work is progressing on this section, which is 2,090 feet in length, and it will probably be completed in July.

Surveys for the other sections of the sewer are now in progress.

Owing to the fact that the sewer is located almost entirely through private property, delay is experienced in making agreements with the owners of the land as to the exact location of the sewer. Construction will, however, be commenced on several sections in April, 1890, and the completion of the entire sewer is anticipated in 1891.

In the original plan for the Improved Sewerage System for the City of Boston, provision was made for the future construction of the intercepting sewer to Dorchester, and a connection was left in the main sewer, near Mt. Vernon street in Dorchester. This connection was built at a low grade, which was properly adjusted to the future extension of the sewer.

In 1885 the Sewer Department was given authority by the city government to build the Dorchester intercepting sewer from its junction with the main sewer as far as Glover's Corner. The officials then in charge of the Sewer Department changed the grade of the sewer by raising it five feet above the height at which it was originally designed to be built. As a consequence, great difficulty is now experienced in extending this sewer as far as Dorchester Lower Mills; and in order to properly intercept the sewage from the common sewer at Granite avenue, the intercepting sewer will have to be built at a very flat grade, and more labor will be required to keep it free from deposits than would have

been necessary if it could have been extended on the grade contemplated in the original design.

The completion of the Dorchester intercepting sewer will furnish an outlet with which the towns of Dedham, Hyde Park, and Readville will in the future connect their sewers. This connection should yield a revenue to the City of Boston for the use of the outlet and the disposal of the sewage at Moon Island. The Neponset river will be purified, and a nuisance, now a source of constant complaint at the Lower Mills, will be mitigated.

The amount of money expended on Improved Sewerage during the year past is \$18,281.45.

The main sewer, which extends up the Stony brook valley, and which this order proposed to extend, is a "common sewer." This sewer is intercepted and brought in to the Improved Sewerage System at Elmwood street in Roxbury. While it is undoubtedly important that this common sewer should be extended as the order provided, it was manifestly outside of the provisions of the "Act to enable the City of Boston to extend its Improved Sewerage System," and the order failed to pass.

## D. — PARKS.

From the City Engineer's report to the Board of Park Commissioners : —

## THE PARKWAY — BACK BAY FENS.

*Excavation of Waterway.* — The dredger was employed during the early part of the season in completing the work of deepening the channel, as described in the last annual report; the site of the proposed bridge at the junction of Audubon road and the Fenway has been dredged, and early in October, there being no other work which could be done by the dredger at present, the force was suspended.

On December 17 work was resumed for a few days to excavate the earth dam left by the Sewer Department at the outlet of the new channel for Stony brook. This work has been finished, and until the channel from the Fen bridge to Brookline avenue can be built, there will be nothing for the dredger to do.

*Grading of Marsh.* — The area of marsh land has been but slightly added to during the year, but considerable work has been done in seeding and sodding the areas previously graded.

*Drainage.* — Catch-basins have been built in Audubon road, and drains laid for conveying the water collected by them into the channel.

*Roadways and Walks.* — During the winter of 1888–9, 7,015 tons of stone were purchased for surfacing roads and walks, and a small force of men and teams kept at work operating the crusher and piling the stone. The average cost of the stone delivered at the crusher was 93 cents per ton of 2,000 lbs., and the total cost of the crushed stone, including material, crushing, screening, teaming, depositing in piles, and all other expenses, was \$1.54 per ton. The piles of crushed stone and screenings were also measured, and it was found that the product cost in the piles \$2.05 per cubic yard. On January 30 a contract was made with James J. Vernon, of Lanesville, Mass., for furnishing curbstone for Audubon road to the Fen bridge, and for the Fenway from Agassiz road to and including Huntington entrance. He delivered under this contract 6,248 lineal feet of curbstone at \$1.57 per lineal foot.

A contract was also made with S. & R. J. Lombard for furnishing paving-blocks, under which there were delivered 70,914 blocks, at \$45 per M.

Seventeen hundred lineal feet of Audubon road southerly from Agassiz road have been macadamized, the curbstone set, gutters paved, and the walk bordering the road on its easterly side has been finished; this road has not, however, been open to travel, there being at present no outlet at its southerly end.

In addition to the above the walk through the Fenside, southerly from a point near the easterly end of Agassiz road, has been nearly completed as far as the Stony-brook gatehouse; and from this point the walk has been sub-graded around the easterly and southerly sides of the basin to the junction of the Fenway and Audubon road, excepting the portion opposite Huntington entrance.

The crushed stone, curbstone, and paving-blocks required for the completion of the Fenway between Westland and Huntington entrances and for Huntington entrance have been purchased, but the work has not been done, the Sewer Department not having yet completed its work at the outlet of the new channel for Stony brook.

*Grading of Slopes, Loaming, and Planting.* — The large area described in the last annual report as graded has been planted, and nearly four acres, in addition, prepared for planting.

The foundations for the bridge over the outlet of the new channel for Stony brook has been completed by the Sewer Department, but the superstructure is yet to be built.

The following table gives the principal items of work completed to date : —

			Per cent of whole.
Channel, excavated . . .	1,148,000 sq. ft. . .	.	90
Shore, completed . . .	23,000 lin. ft. . .	.	82
Marsh, " . . .	828,000 sq. ft. . .	.	99
Driveway, " . . .	46,500 sq. yds. . .	.	52
Walks, " . . .	19,100 " . . .	.	37
Ride, " . . .	3,000 " . . .	.	23
Curbing, " . . .	22,100 lin. ft. . .	.	59
Gutters, " . . .	10,200 sq. yds. . .	.	53
Area covered with loam, . . .	867,000 sq. ft. . .	.	63
Area planted . . .	711,000 sq. ft. . .	.	52
Boundary fence . . .	4,000 lin. ft. . .	.	26
Drains laid . . .	5,545 " . . .	.	
Catch-basins . . .	65 . . .	.	
Man-holes . . .	6 . . .	.	

Much work besides that included in the table has been but partially completed, and cannot yet be classified.

A considerable force has also been employed through the year in the care of the plantations, roads, walks, etc.

#### ARNOLD ARBORETUM.

The spring or well at the foot of Bussey hill has been covered, and the ground about it graded. On Sept. 19 work was begun on the grading of the driveway leading from the present road to the Walter-street entrance, and the work is now in progress. One of the culverts over the brook has been built. The other work done during the year has been that required for the care of the roads and of the plantations on the city's reservation at the summit of Bussey hill.

#### FRANKLIN PARK.

*Drives and Walks.* — During the year the Old Trail road, Seaver street, opposite Humboldt avenue, to the westerly end of the Greeting, and the adjacent walks, have been completed.

Glen lane has been completed from Glen road to a point 300 feet beyond the Valley gate, and for 600 feet farther has been sub-graded.

The circuit drive has been completed from the Valley-gate entrance to near the corner of Walnut and Ellicott streets, and the walks in its vicinity are nearly finished. The walks in the rear of the Playstead Shelter have been completed. About 1,200 lineal feet of the Loop road in the Wilderness have been sub-graded, and a portion of it covered with stone. Work is now in progress sub-grading the drive from the present terminus of the circuit drive to the top of Scarboro' Hill.

*Playstead, Shelter, and Green.* — A spring near the junction of the Playstead road and the Greeting has been preserved and carried by a pipe across the road to a rustic fountain, or covered pool, where it furnishes a continuous flow of good drinking-water. A flag and pennant were purchased for the large flagstaff, and the pennant has been displayed on every pleasant day except Sundays and holidays, when the ensign has been shown.

*Gateways.* — The Valley gate, at the entrance to the Country park, from the Playstead district, has been completed in accordance with the description given in the last annual report.

*Boundary Wall for the Country Park.* — A wall has been built along the southerly side of Glen road and of Glen lane



from the westerly boundary of the park to a point on Glen lane about 900 feet east of the Valley gate.

*Ellicott Arch.* — This bridge, which is a brick masonry arch, 71 feet in length, 17.5 feet in span, and 15 feet in height above the walk, has been completed. The ends of the arch and the adjoining retaining-walls are of rustic masonry, built of field stone found in the vicinity. Arched recesses were constructed along the sides, in which seats are to be placed.

*Ellicottdale.* — This ground was generally a rocky swamp, and its treatment involved a large amount of labor; hundreds of boulders had to be broken and removed, and nearly the whole area required to be sub-drained; much of the ground also needed grading, in order to make it suitable for its intended use. This work, with the exception of ploughing and seeding, has been nearly finished.

*Drainage of Nazingdale.* — About two-fifths of the whole park is included in one drainage area, the outlet for which is through a culvert under Canterbury street. At the head of this drainage area is the easterly portion of the Playstead and a part of Long Crouch woods. Consequently, a main drain extending through the valley would be nearly a mile in length, and at its lower end would be about five feet in diameter. It had been thought that the summer flow of water from the valley would be so slight that an open channel or brook would be unsightly in dry weather, but the expense of a covered drain being so great, it was determined to make an open channel through the lower part of the valley. This channel has been treated so as to have the appearance of a natural brook, and work upon it is nearly finished. At the lower part of the valley a temporary dam has been built, which floods about three acres of ground for a small skating-pond. The covered drain ends at a point about fifty feet south of the old location of William street, and above this point the main drain, with the exception of about 150 feet, has been completed as far as the Old Trail road.

The following table gives the principal items of work completed to date, but it does not include all the work done, a large amount of labor and materials having been expended on work which has not been sufficiently finished to admit of classification: —

Drive-ways completed . . .	45,000 sq. yds., or $2\frac{2}{3}$ miles.
Walks completed . . .	27,500 sq. yds., or $3\frac{1}{2}$ miles.
Gutters paved . . .	8,600 sq. yds.
Curbstone set . . .	2,700 lin. ft.

6-in. water-pipe laid . . .	3,000 lin. ft.
Hydrants . . . . .	6
Drinking-fountains . . . .	5
Bridge . . . . .	1
Boundary wall . . . . .	2,700 lin. ft.
2 ft. 9 in. brick drain . . .	450 "
2 ft. x 2 ft. 6 in. brick drain,	180 "
2-ft. brick drain . . . . .	769 "
18-in. pipe drain . . . . .	1,860 "
15-in. pipe drain . . . . .	2,239 "
12-in. pipe drain . . . . .	1,351 "
10-in. pipe drain . . . . .	1,134 "
8-in. pipe drain . . . . .	4,787 "
4-in. pipe drain . . . . .	190 "
4-in. agricultural tile drain .	2,100 "
3-in. agricultural tile drain .	2,420 "
2-in. agricultural tile drain .	24,613 "
Total drain . . . . .	42,093 "
Man-holes . . . . .	27
Catch-basins and inlets . . .	80
Open channel for brook . . .	2,300 lin. ft.
Area of ground graded and planted, or seeded . . . . .	62 acres.

There have also been roughly graded or sub-graded about 3,300 lineal feet of drive-way.

#### MARINE PARK.

*Iron Pier.* — The four spans contracted for Oct. 20, 1888, have been completed, and this addition to the pier was opened to the public on August 29. One other span, to connect the iron pier with the pier-head, has been contracted for, and will be put in place as soon as the work on the pier-head is sufficiently advanced.

*Pier-Head.* — On March 23 a contract was made with Joseph E. White for the construction of the pier-head, and this work is now in progress. The structure consists of an island, somewhat pear-shaped in plan, built of gravel, with its outer line protected by a sloping wall of ballast and rip-rap, surmounted by a parapet of cut granite.

At the side toward the iron pier there is an abutment of masonry laid in cement mortar, and in the centre a circular wall has been built, to serve as a foundation for an iron structure. The grade of the surface of the pier-head is to be about fifteen feet above city base. This artificial island

is filled on a mud foundation, and consequently there will be more or less settlement for several years.

*Filling.* — October 5 a contract was made for furnishing 200,000 cubic yards of filling to grade the southerly portion of the park. About 25,000 cubic yards have been deposited to date.

#### WOOD ISLAND PARK.

On September 19 the excavation of the site of the proposed playground and the grading of the concourse near the bridge over the railroad was commenced, and this work is now in progress.

#### CHARLESBANK.

*Plantations.* — The entire area of the park, excepting the walks and gymnastic grounds, has been planted during the past season.

*Lamps.* — Gas-lamps have been placed along the river wall, and since July 28 they have been lighted at night.

*Buildings.* — The old brick building which was used for a temporary office has been removed, and a new building, near the northerly boat-landing, has been constructed by W. H. Keyes & Co., under the direction of the City Architect. The building is 20 feet by 50 feet on the ground, and is two stories in height. The lower story contains offices for the police and foreman, storerooms for tools, etc., and a room for the use of the boat-keeper. The upper story is divided into two rooms, one of which contains water-closets, urinals, and lavatories, and the other is the entrance to the gymnastic ground, and is provided with boxes for clothing.

This room is connected with the gymnastic ground by a bridge over the walk and bicycle track, with stairs from its outer end leading to the ground, and the only entrance to and exit from the gymnastic ground is through turnstiles at the entrance to the bridge.

*Gymnastic Ground.* — The gymnastic ground was opened to the public on August 27. This ground has been provided with apparatus consisting of 2 sheds, with 10 sets of chest weights in each, 2 giant stride poles, 12 sets of horizontal bars, 8 sets of parallel bars, 6 jumping-boxes, 7 sets of boxes for quoit pitching, hammer and shot throwing, and two large frames, each 160 feet long, to which are attached swings, trapezes, ropes and poles for climbing, ladders, flying-rings, etc. Around the outside of the ground there is a running and bicycle track, 15 feet wide and one-fifth of a mile long. The apparatus was designed from sketches furnished by D. A.

Sargent, M.D., Professor of Physical Culture of Harvard University. Two drinking-fountains have been erected within the enclosure. The grounds at the southerly end of the park have been rearranged to conform to a new plan for a girls' gymnasium and children's playground.

*Muddy-river and Stony-brook Covered Channels.* — These remain in the same condition as described in the last annual report.

### REFERENCE LIBRARY.

I have the pleasure of acknowledging a donation to the Reference Library of this department of a number of pamphlets. Among these were 109 reports and papers relating to the Boston Water-Supply, which are of special value, and have been bound for their better preservation.

These reports were from the library of the late Hon. N. J. Bradlee, a former president of the Cochituate Water Board, and were presented to the department by Mrs. Bradlee.

### WIDTHS OF DRAW-OPENINGS.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in Appendix A. The openings have all been remeasured for this report.

WILLIAM JACKSON,  
*City Engineer.*



# CITY ENGINEERS.

1850-1889.

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E. S. CHESBROUGH, M. Am. Soc. C. E.,  
Nov. 18, 1850, to Oct. 1, 1855.<sup>1</sup>

JAMES SLADE,  
Oct. 1, 1855, to April 1, 1863.<sup>2</sup>

N. HENRY CRAFTS,  
April 1, 1863, to Nov. 25, 1872.

JOSEPH P. DAVIS, M. Am. Soc. C. E.,  
Nov. 25, 1872, to March 20, 1880.<sup>3</sup>

HENRY M. WIGHTMAN, M. Am. Soc. C. E.,  
April 5, 1880, to April 3, 1885.<sup>4</sup>

WILLIAM JACKSON, M. Am. Soc. C. E.,  
April 21, 1885, to present time.

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<sup>1</sup> Died August 18, 1886.

<sup>2</sup> Died August 25, 1882.

<sup>3</sup> Resigned March 20, 1890.

<sup>4</sup> Died April 6, 1885.



## APPENDICES.



## APPENDIX A.

*Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1890.*

NAME OF BRIDGES.	LOCATION.	NUMBER OF OPENINGS.	WIDTH.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown	1	35	7
" "	Over Miller's River	1	35	8
Broadway	Over Fort-Point Channel	1	43	3
Cambridge-st.	Ward 25 to Cambridge	1	30	8
Canal	Boston to East Cambridge	1	35	10
Charles-river	Boston to Charlestown	1	36	0
Chelsea (South Channel)	Charlestown to Chelsea	1	38	10
" (North " )	" "	1	44	7
Chelsea-st. (East Boston side)	East Boston to Chelsea	1	33	1
" (Chelsea side)	" "	2	34	3
Commercial-point	Ward 24	1	24	0
Congress-st. (Boston side)	Over Fort-Point Channel	2	43	3
" (South Boston side)	" "	1	43	11
Dover-st.	" "	1	36	0
Eastern R.R.	Boston to Charlestown	1	35	10
" "	Over Miller's River	1	35	8
Essex-st.	Ward 25 to Cambridge	1	30	11
Federal-st.	Over Fort-Point Channel	1	36	0
Fitchburg R.R.	Boston to Charlestown	1	36	0

Fitchburg R.R. (for teaming freights)	.	.	Boston to Charlestown	.	1	36	0
Grand Junction R.R.	.	.	Ward 25 to Cambridge	.	1	35	0
"	.	.	East Boston to Chelsea	.	1	34	8
Granite	.	.	Ward 24 to Milton	.	1	36	0
Harvard (Boston side)	.	.	Boston to Cambridge	.	2	36	8
" (Cambridge side)	.	.	" "	.		36	8
Lowell R.R. (freight)	.	.	Boston to East Cambridge	.	1	35	8
" (passenger)	.	.	" "	.	1	35	10
Malden	.	.	Charlestown to Everett	.	1	43	4
Meridian-st. (East Boston side)	.	.	East Boston to Chelsea	.	2	59	0
" (Chelsea side)	.	.	" "	.		59	0
Mt. Washington-ave. (Boston side)	.	.	Over Fort-Point Channel	.	2	42	1
" (So. Boston side)	.	.	" "	.		42	4
Neponset	.	.	Ward 24 to Quincy	.	1	36	0
New York & New England R.R. (Boston side)	.	.	Over Fort-Point Channel	.	2	40	8
" " (So. Boston side)	.	.	" "	.		40	8
"	.	.	Over South Bay	.	1	28	4
North Beacon-st.	.	.	Ward 25 to Watertown	.	1	30	2
North Harvard-st.	.	.	Ward 25 to Cambridge	.	1	31	8
Old Colony R.R.	.	.	Over Fort-Point Channel	.	1	36	0
"	.	.	Ward 24 to Quincy	.	1	36	0
Prison-point	.	.	Charlestown to Cambridge	.	1	35	6
Warren	.	.	Boston to Charlestown	.	1	36	3
West Boston (Boston side)	.	.	Boston to Cambridge	.	2	35	8
" (Cambridge side)	.	.	" "	.		36	0
Western-ave.	.	.	Ward 25 to Cambridge	.	1	31	3
"	.	.	Ward 25 to Watertown	.	1	30	0

## APPENDIX B.

CITY ENGINEER'S REPORTS, 1868-1889.<sup>1</sup>

Year.	Doc.	Year.	Doc.	Year.	Doc.
1868.....	22	1877.....	15	1884.....	55
1869-70.....	14	1878.....	20	1885.....	54
1871.....	15	1879.....	22	1886.....	41
1872-73.....	23	1880.....	33	1887.....	38
1874.....	20	1881.....	25	1888.....	39, 117
1875.....	19	1882.....	52	1889.....	38
1876.....	24	1883.....	53		

<sup>1</sup> The dates given are for the year in which the document was published.

# CONTENTS CITY ENGINEER'S REPORTS,

**1868-1889.**

SUBJECT.	Year.	Doc.	Page.
Adams-street bridge (over O. C. R.R.).....	1885	54	28
“ “ “ “ “ .....	1886	41	20
“ “ “ “ “ .....	1887	38	16
Adams-street survey.....	1868	22	29
Additional water-supply.....	1874	20	15
“ “ .....	1875	19	12
“ “ .....	1876	24	8
“ “ .....	1877	15	37
“ “ .....	1878	20	35
“ “ .....	1879	22	32
“ “ .....	1880	33	27
“ “ .....	1881	25	27
“ “ .....	1889	38	60
Agassiz bridge (in B. B. Fens).....	1888	39	33
“ “ “ “ “ .....	1888	117	5
“ “ “ “ “ .....	1889	38	6, 64
Albany-street bridge (over B. & A. R.R.) .....	1868	22	21
“ “ “ “ “ “ .....	1870	14	37
“ “ “ “ “ “ .....	1871	15	69
“ “ “ “ “ “ .....	1873	23	46
“ “ “ “ “ “ .....	1874	20	35
“ “ “ “ “ “ .....	1875	19	38
“ “ “ “ “ “ .....	1876	24	32
“ “ “ “ “ “ .....	1877	15	24
“ “ “ “ “ “ .....	1878	20	26
“ “ “ “ “ “ .....	1879	22	22
“ “ “ “ “ “ .....	1880	33	17
“ “ “ “ “ “ .....	1881	25	16
“ “ “ “ “ “ .....	1882	52	19
“ “ “ “ “ “ .....	1883	53	19
“ “ “ “ “ “ .....	1884	55	19
“ “ “ “ “ “ .....	1885	54	22
“ “ “ “ “ “ .....	1886	41	18
“ “ “ “ “ “ .....	1887	38	14
“ “ “ “ “ “ .....	1888	39	14
“ “ “ “ “ “ .....	1888	117	15
“ “ “ “ “ “ .....	1889	38	17
Albany-street bridge (over Roxbury canal).....	1870	14	29
“ “ “ “ “ “ .....	1871	15	54
“ “ “ “ “ “ .....	1873	23	38
“ “ “ “ “ “ .....	1874	20	21
“ “ “ “ “ “ .....	1875	19	19
“ “ “ “ “ “ .....	1876	24	12
“ “ “ “ “ “ .....	1877	15	8
“ “ “ “ “ “ .....	1878	20	8
“ “ “ “ “ “ .....	1879	22	7
Albany-street pipe-yard sea-wall.....	1888	39	24
Albany-street wall .....	1868	22	12

<sup>1</sup> The dates given are for the year in which the document was published.

SUBJECT.	Year.	Doc.	Page.
Alford-street sea-wall.....	1881	25	17
“ “ .....	1882	52	20
Algæ .....	1880	33	27
Aqueducts and distributing reservoirs.....	1889	38	49
Army and navy monument.....	1875	19	43
Arnold Arboretum, P. ....	1884	55	52
“ “ .....	1885	54	51
“ “ .....	1887	38	30
“ “ .....	1888	39	34
“ “ .....	1889	38	65
Artesian borings, M. D. ....	1878	20	38
Ashland-street bridge (over B. & P. R.R.) .....	1875	19	19
“ “ “ “ “ .....	1876	24	13
“ “ “ “ “ .....	1877	15	8
“ “ “ “ “ .....	1878	20	8
“ “ “ “ “ .....	1879	22	7
“ “ “ “ “ .....	1880	33	7
“ “ “ “ “ .....	1881	25	7
“ “ “ “ “ .....	1882	52	8
“ “ “ “ “ .....	1883	53	7, 19
“ “ “ “ “ .....	1884	55	7
“ “ “ “ “ .....	1885	54	8
“ “ “ “ “ .....	1886	41	9
“ “ “ “ “ .....	1887	38	6
“ “ “ “ “ .....	1888	39	5
“ “ “ “ “ .....	1888	117	6
“ “ “ “ “ .....	1889	38	6
Ashmont-street bridge (over O. C. R.R.) .....	1884	54	20
Athens-street bridge (over N. Y. & N. E. R.R.) .....	1875	19	20
“ “ “ “ “ “ .....	1876	24	13
“ “ “ “ “ “ .....	1877	15	8
“ “ “ “ “ “ .....	1878	20	8
“ “ “ “ “ “ .....	1879	22	7
“ “ “ “ “ “ .....	1880	33	7
“ “ “ “ “ “ .....	1881	25	7
“ “ “ “ “ “ .....	1882	52	8
“ “ “ “ “ “ .....	1883	53	8
“ “ “ “ “ “ .....	1884	55	7
“ “ “ “ “ “ .....	1885	54	8
“ “ “ “ “ “ .....	1886	41	9
“ “ “ “ “ “ .....	1887	38	7
“ “ “ “ “ “ .....	1888	39	6
“ “ “ “ “ “ .....	1888	117	5
“ “ “ “ “ “ .....	1889	37	7
Atlantic-avenue filling.....	1871	15	42
“ retaining-wall, near Russia wharf.....	1875	19	41
“ soundings.....	1870	14	9
“ sea-wall .....	1871	15	41
“ sidewalk.....	1883	53	20
“ “ .....	1885	54	24
“ survey.....	1870	14	9
<b>Back Bay:—</b>			
“ “ bridges .....	1873	23	26
“ “ Fens.....	1888	39	31
“ “ “ .....	1889	38	63
“ “ filling .....	1882	52	43
“ “ “ .....	1883	53	48
“ “ “ .....	1884	55	48

SUBJECT.	Year.	Doc.	Page.
Back Bay filling.....	1885	54	49
" " ".....	1886	41	46
" " improvement .....	1886	41	46
" " ".....	1887	38	30
" " park .....	1879	22	24
" " ".....	1885	54	49
" " ".....	1889	38	63
Basins, Water-Works:—			
Nos. 2, 3, 4.....	1884	55	32
Basin No. 4.....	1885	54	34
" " 5.....	1889	38	58
Basin 1 dam.....	1879	22	35
" 2 ".....	1880	33	29
" 3 ".....	1880	33	30
" 2 shallow flowage.....	1884	55	32
" 3 ".....	1884	55	32
" 3 ".....	1887	38	18
" 4 ".....	1886	41	24
Beachmont avenue.....	1888	39	17
Beacon-entrance bridge:—			
(B. B. Fens, over B. & A. R.R.).....	1882	52	45
" " ".....	1883	53	8, 48
" " ".....	1884	55	7, 50
" " ".....	1885	54	8
" " ".....	1886	41	9
" " ".....	1887	38	7
" " ".....	1888	39	6
" " ".....	1888	117	6
" " ".....	1889	38	7
Beacon-hill high-service, W.W....	1871	15	19
Beacon street .....	1883	53	25
" " raising grade .....	1887	38	16
" " " pipe.....	1887	38	22
" " ".....	1888	39	24
Beacon street and Brookline avenue.....	1885	54	24
Beacon-street bridge (over B. & A. R.R.) .....	1873	23	35
" " ".....	1885	54	3, 8
" " ".....	1886	41	9
" " ".....	1887	38	7
" " ".....	1888	39	7
" " ".....	1888	117	6
" " ".....	1889	38	7
Beacon-street bridge (over outlet of B. B. Fens pond; see, also, Mill-dam bridge)	1881	25	18
" " ".....	1882	52	8
" " ".....	1883	53	8
" " ".....	1884	55	8
" " ".....	1885	54	8
" " ".....	1886	41	9
" " ".....	1887	38	7
" " ".....	1888	39	6
" " ".....	1888	117	6
" " ".....	1889	38	7
Beacon-street widening .....	1880	33	21
" " ".....	1881	25	19
Beacon-street and Commonwealth-avenue bridges .....	1882	52	45
Beech-street bridge (over B. & P. R.R.).....	1878	20	27
" " ".....	1883	53	19

SUBJECT.	Year.	Doc.	Page.
Beech-street bridge (over B. & P. R.R.) .....	1884	55	20
“ “ “ “ “ .....	1885	54	23
“ “ “ “ “ .....	1886	41	20
“ “ “ “ “ .....	1887	38	15
“ “ “ “ “ .....	1888	39	15
Bellevue-avenue bridge (over B. & P. R.R.) .....	1887	38	15
“ “ “ “ “ .....	1888	39	15
Bennington-street extension .....	1887	38	16
Berkeley-street bridge (over B. & A. R.R.) .....	1868	22	23
“ “ “ “ “ .....	1870	14	38
“ “ “ “ “ .....	1871	15	69
“ “ “ “ “ .....	1873	23	47
“ “ “ “ “ .....	1874	20	22
“ “ “ “ “ .....	1875	19	21
“ “ “ “ “ .....	1876	24	14
“ “ “ “ “ .....	1877	15	8
“ “ “ “ “ .....	1878	20	8
“ “ “ “ “ .....	1879	22	8
“ “ “ “ “ .....	1880	33	7
“ “ “ “ “ .....	1881	25	7
“ “ “ “ “ .....	1882	52	10
“ “ “ “ “ .....	1883	53	8
“ “ “ “ “ .....	1884	55	8
“ “ “ “ “ .....	1885	54	8
“ “ “ “ “ .....	1886	41	9
“ “ “ “ “ .....	1887	38	7
“ “ “ “ “ .....	1888	39	7
“ “ “ “ “ .....	1888	117	6
“ “ “ “ “ .....	1889	38	7
Berkeley-street bridge (over B. & P. R.R.) .....	1870	14	39
“ “ “ “ “ .....	1871	15	70
“ “ “ “ “ .....	1873	23	47
“ “ “ “ “ .....	1874	20	22
“ “ “ “ “ .....	1875	19	21
“ “ “ “ “ .....	1876	24	14
“ “ “ “ “ .....	1877	15	8
“ “ “ “ “ .....	1878	20	9
“ “ “ “ “ .....	1879	22	8
“ “ “ “ “ .....	1880	33	7
“ “ “ “ “ .....	1881	25	8
“ “ “ “ “ .....	1882	52	10
“ “ “ “ “ .....	1883	53	8
“ “ “ “ “ .....	1884	55	8
“ “ “ “ “ .....	1885	54	9
“ “ “ “ “ .....	1886	41	10
“ “ “ “ “ .....	1887	38	7
“ “ “ “ “ .....	1888	39	7
“ “ “ “ “ .....	1888	117	6
“ “ “ “ “ .....	1889	38	7
Berkeley-street retaining-walls .....	1871	15	49
“ “ “ “ “ .....	1874	20	37
“ “ “ “ “ .....	1877	15	26
Berwick-park retaining-wall .....	1876	24	35
Blakemore-street bridge (over B. & P. R.R.) .....	1881	25	23
“ “ “ “ “ .....	1882	52	10, 20
“ “ “ “ “ .....	1883	53	9
“ “ “ “ “ .....	1884	55	8
“ “ “ “ “ .....	1885	54	9
“ “ “ “ “ .....	1886	41	10

SUBJECT.	Year.	Doc.	Page.
Blakemore-street bridge (over B. & P. R.R.) .....	1887	38	7
“ “ “ “ “ .....	1888	39	7
“ “ “ “ “ .....	1888	117	6
“ “ “ “ “ .....	1889	38	8
B. & A. R.R. bridge (over Park water-way) .....	1882	52	45
“ “ “ “ “ .....	1883	53	49
Boilers, Chestnut-hill Pumping-station .....	1888	39	17
“ Highland “ .....	1878	20	31
“ Mystic “ .....	1884	55	34
Boylston-street arch bridge .....	1881	25	41
“ “ “ “ “ .....	1882	52	44
“ “ “ “ “ .....	1883	53	49
“ “ “ “ “ .....	1884	55	8, 50
“ “ “ “ “ .....	1885	54	9, 50
“ “ “ “ “ .....	1886	41	10
“ “ “ “ “ .....	1887	38	7
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(Box on 2)

ENGINEERING DEPARTMENT.

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TWENTY-FOURTH ANNUAL REPORT

OF THE

CITY ENGINEER,

---

BOSTON,

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FOR THE YEAR 1890.

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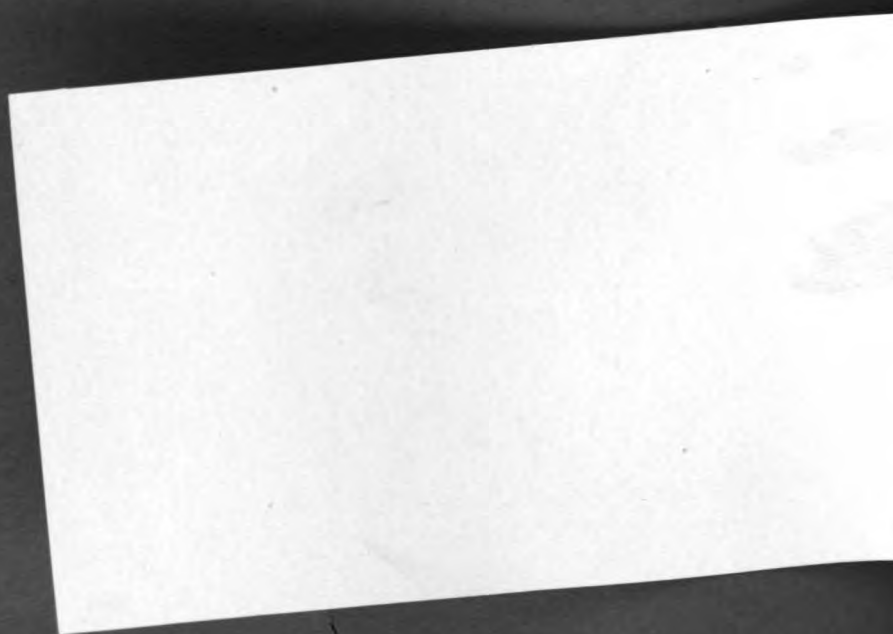
Printed for the Department.



BOSTON:

ROCKWELL AND CHURCHILL, CITY PRINTERS.

1891.



# ENGINEERING DEPARTMENT.

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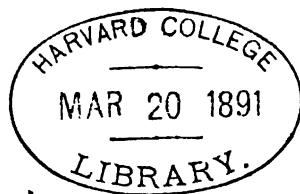
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Printed for the Department.



BOSTON:  
ROCKWELL AND CHURCHILL, CITY PRINTERS.

1891.



William Jackson,  
City Engineer.

ENGINEERING DEPARTMENT, CITY HALL,  
BOSTON, Jan. 6, 1891.

HON. NATHAN MATTHEWS, JR.,  
*Mayor of the City of Boston:—*

SIR,—In compliance with the Revised Ordinances of 1890 the following report of the expenses and operations of the department for the year 1890 is respectfully submitted.

The duties of the City Engineer may be classified under the following heads:—

A.—Those pertaining to the Engineering Department proper, which consist in examination and supervision of structural repairs of bridges, in designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council. (Engineering Department.)

B.—Charge of the engineering work in connection with the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works. (Water-Works.)

C.—Charge of the construction of a system of intercepting and outlet sewers. (Improved Sewerage, or Main Drainage.)

D.—Charge of the engineering work in connection with the parks. (Parks.)

The expenses incurred under the head C are paid wholly from a special appropriation.

A.—ENGINEERING DEPARTMENT.

The following is a statement of engineering expenses from January 1, 1890, to January 1, 1891:—

Amount expended from department appropriation for 1889-90 . . . . .	\$9,558 32
Amount expended from department appropriation for 1890-91 . . . . .	25,832 09
Total . . . . .	<hr/> \$35,390 41



Condition of department appropriation : —

Amount of appropriation for financial year 1890-91 . . . . .	\$36,000 00
Amount expended to January 1, 1891 . . . . .	25,832 09
Unexpended balance, department appropriation, January 1, 1891 . . . . .	\$10,167 91

#### FERDINAND-STREET BRIDGE.

Appropriation for rebuilding . . . . .	\$35,000 00
Expended to January 1, 1891 . . . . .	43 80
Unexpended balance . . . . .	34,956 20
Total unexpended balances Jan. 1, 1891 . . . . .	\$45,124 11

#### CLASSIFICATION OF EXPENSES.

Salaries of City Engineer, assistants, draughtsmen, transitmen, levellers, rodmen, etc. . . . .	\$32,685 50
Engineering instruments and repairs of same . . . . .	98 55
Drawing-paper, and all materials for making plans . . . . .	210 35
Stationery, printing-stock, note-books, postage, etc. . . . .	223 92
Reference library, binding books, and photographs of works . . . . .	542 10
Printing . . . . .	67 54
Travelling expenses (including horse-keeping, repairs on vehicle, etc.) . . . . .	790 21
Telephone service . . . . .	184 83
Furniture cases for plans and books, etc. . . . .	240 75
Blue-process printing . . . . .	26 00
Incidental expenses, and all other small supplies . . . . .	320 66
Total . . . . .	\$35,390 41

The number of persons employed and paid from the department appropriation was, on the 1st of January, 1890, 20; the present number (including the City Engineer) is 23. The operations of the department for the year, together with such general information relating to the various works and structures, finished and in progress, as is thought to be of interest, are given in the following statements : —

## BRIDGES.

The adoption of a set of Revised Ordinances during the year has made a change in the duties of this department in the matter of the maintenance of highway bridges in the city.

The new ordinances provide that the City Engineer "shall, upon being notified by the Superintendent of Bridges, supervise all repairs on the bridges of the city used as highways, which affect the safety of the structures;" and also that "said Engineer shall in his annual report include a report of the safety and completeness of all bridges within the city limits used as highways."

Since the passage of the ordinance the City Engineer has been notified by the Superintendent of Bridges in twenty-four cases, that bridges have been "stripped preparatory to repairing the same," and in these cases the bridges have been examined and plans and supervision of repairs furnished when necessary.

The inspection of bridges with respect to "safety and completeness" has been made, and, in conformity to previous practice, has included all such bridges as the Public Garden foot-bridge and the Park bridges, without inquiry into their legal status as highways.

Federal-street bridge is in process of rebuilding.

Four bridges on the upper Charles river, between Boston and Cambridge,—namely, North Harvard street, Western avenue to Cambridge, Cambridge street, and Essex street bridges,—are being partially reconstructed in order to make the draw-openings in them a uniform width of 36 feet, as directed by the Massachusetts Legislature in Chapter 230, Acts of 1888. For details, see under head of each bridge.

A contract has been made for a new iron bridge on Ferdinand street. See page 14.

The order of the Secretary of War requiring the rebuilding of the four highway bridges on the lower Charles river, namely, West Boston, Canal, Warren, and Charles-river bridges, has been suspended indefinitely. The hearings before a Commission of Engineer Officers, in January, were attended, and such information as was desired was furnished to the Commission.

## LIST OF BRIDGES INSPECTED.

Gold-street bridge, over N.Y. & N.E. R.R., has been added to the list this year.

In the list, those marked with an asterisk are over navigable water, and are each provided with a draw.

### I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Agassiz road, in Back-Bay Fens.

Ashland street, Ward 23, over Boston & Providence Railroad.

Athens street, over New York & New England Railroad.

Beacon entrance, Back-Bay Fens, over Boston & Albany Railroad.

Beacon street, over outlet to Back-Bay Fens.

Beacon street, over Boston & Albany Railroad.

Berkeley street, over Boston & Albany Railroad.

Berkeley street, over Boston & Providence Railroad.

Blakemore street, over Boston & Providence Railroad, Ward 23.

Bolton street, over New York & New England Railroad.

Boylston street, in Back-Bay Fens.

Boylston street, over Boston & Albany Railroad.

\* Broadway, over Fort-Point Channel.

Broadway, over Boston & Albany Railroad.

Brookline avenue, over Boston & Albany Railroad.

Byron street, over Boston, Revere Beach, & Lynn Railroad.

\* Charles river, from Boston to Charlestown.

\* Chelsea (south), over South Channel, Mystic river.

\* Chelsea street, from East Boston to Chelsea.

Columbus avenue, over Boston & Albany Railroad.

\* Commercial point, or Tenean, Ward 24.

Commonwealth avenue, in Back-Bay Fens.

\* Congress street, over Fort-Point Channel.

Cottage-street foot-bridge, over Flats, East Boston.

Dartmouth street, over Boston & Albany and Boston & Providence Railroads.

\* Dover street, over Fort-Point Channel.

\* Federal street, over Fort-Point Channel.

Ferdinand street, over Boston & Albany Railroad.

Franklin-street foot-bridge, over Boston & Albany Railroad.

Gold-street foot-bridge, over New York & New England Railroad.

Huntington avenue, over Boston & Albany Railroad.

Leyden street, over Boston, Revere Beach, & Lynn Railroad.

Linden Park street, over Stony brook.

\* Malden, from Charlestown to Everett.

- \* Meridian street, from East Boston to Chelsea.
- \* Mt. Washington avenue, over Fort-Point Channel.
- Neptune road, over Boston, Revere Beach, & Lynn Railroad.
- Newton street, over Boston & Providence Railroad.
- Public Garden foot-bridge.
- Shawmut avenue, over Boston & Albany Railroad.
- Swett street, east of New York & New England Railroad.
- Swett street, west of New York & New England Railroad.
- \* Warren, from Boston to Charlestown.
- West Chester park, over Boston & Albany Railroad.
- West Chester park, over Boston & Providence Railroad.
- West Rutland square foot-bridge, over Boston & Providence Railroad.
- Winthrop, from Breed's Island to Winthrop.

## II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

- \*Cambridge street, from Brighton to Cambridge.
- Central avenue, from Ward 24 to Milton.
- \*Chelsea (north), from Charlestown to Chelsea.
- \*Essex street, from Ward 25 (Brookline) to Cambridge.
- \*Granite, from Dorchester, Ward 24, to Milton.
- Longwood avenue, from Ward 22 to Brookline.
- Mattapan, from Ward 24 to Milton.
- Milton, from Ward 24 to Milton.
- \*Neponset, from Ward 24 to Quincy.
- \*North Beacon street, from Brighton to Watertown.
- \*North Harvard street, from Brighton to Cambridge.
- Spring street, from West Roxbury to Dedham.
- \*Western avenue, from Brighton to Cambridge.
- \*Western avenue, from Brighton to Watertown.

## III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

- Albany street, over Boston & Albany Railroad.
- \*Canal, from Boston to Cambridge.
- Dorchester street, over Old Colony Railroad.
- \*Harvard, from Boston to Cambridge.
- \*Prison Point, from Charlestown to Cambridge.
- \*West Boston, from Boston to Cambridge.

## IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

*1st. — Boston & Albany Railroad.*

Commonwealth avenue, Brighton.

Harrison avenue.

Market street, Brighton.

Tremont street.

Washington street.

*2d. — Boston & Maine Railroad, Western Division.*

Mystic avenue.

Main street.

*3d. — Boston & Maine Railroad, Eastern Division.*

Mystic avenue.

Main street.

*4th. — Boston, Revere Beach, & Lynn Railroad.*

Everett street.

*5th. — New York & New England Railroad.*

Broadway.

Dorchester avenue.

Fifth street.

Forest Hills avenue, Ward 24.

Fourth street.

Harvard street, Ward 24.

Norfolk “ “ “

Norfolk “ “ “

Second street.

Silver street.

Sixth street.

Third street.

Washington street, Ward 24.

*6th. — Old Colony Railroad.*

Adams street.

Ashmont street and Dorchester avenue.

Cedar Grove Cemetery.

Commercial street.

Savin Hill avenue.

*7th. — Old Colony Railroad, Providence Division.*

Beech street, Ward 23.  
 Bellevue street, Ward 23.  
 Canterbury street, Ward 23.  
 Centre street, or Hog Bridge, Ward 23.  
 Centre and Mt. Vernon streets, Ward 23.  
 Dudley avenue, Ward 23.  
 Park street, Ward 23.

## RECAPITULATION.

I.	Number wholly supported by Boston . . . . .	47
II.	Number of which Boston supports the part within its limits . . . . .	14
III.	Number of which Boston pays a part of the cost of maintenance . . . . .	6
IV.	Number supported by railroad corporations :—	
1.	Boston & Albany . . . . .	5
2.	Boston & Maine, Western Division . . . . .	2
3.	“ “ Eastern Division . . . . .	2
4.	Boston, Revere Beach, & Lynn . . . . .	1
5.	New York & New England . . . . .	13
6.	Old Colony . . . . .	5
7.	“ “ Providence Division . . . . .	7
	Total number . . . . .	102

## I.—BRIDGES WHOLLY SUPPORTED BY BOSTON.

## AGASSIZ-ROAD BRIDGE IN BACK-BAY FENS.

This bridge was built in 1887, of brick and stone masonry. It is maintained by the Park Department, and is in good condition.

## ASHLAND-STREET BRIDGE (OVER BOSTON &amp; PROVIDENCE RAILROAD, WARD 23).

The present structure is of iron, and was built in 1875. The iron-work and fences need painting. The abutments and iron-work, with exception of painting, are in good condition.

**ATHENS-STREET BRIDGE (OVER NEW YORK & NEW  
ENGLAND RAILROAD).**

This is an iron bridge, and was built in 1874. It has been sheathed, but the iron-work is rusty. It should be stripped of wood-work and painted.

**BEACON-ENTRANCE BRIDGE (IN BACK-BAY FENS, OVER  
BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1881-82. It has been stripped, painted, and a new under-floor and a new sheathing laid. It is in good condition.

**BEACON-STREET BRIDGE (OVER OUTLET OF BACK BAY).**

This is an iron bridge, built in 1880-81. The iron-work should be painted, and the wood-work renewed where necessary.

**BEACON-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge; it was built in 1884-85, and was widened in 1887-88. It is in good condition. The central roadway is to be widened two feet by the West End Street Railway Co., at their expense, for the safer accommodation of the electric street-cars.

**BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD.)**

This is an iron bridge. It was built by the Boston Water-Power Company, and was accepted by the city in 1869.

No work of importance has been done upon it during the year. It is a weak and unsafe bridge, and has been so reported for several years.

**BERKELEY-STREET BRIDGE (OVER BOSTON & PROVIDENCE  
RAILROAD).**

This is an iron bridge. It was built by the Boston Water-Power Company, and was accepted by the city in 1869.

Only slight repairs have been made. It is in fair condition.

**BLAKEMORE-STREET BRIDGE (OVER BOSTON & PROVIDENCE  
RAILROAD).**

This is an iron bridge, and was built in 1881-82. It is in good condition.

**BOLTON-STREET BRIDGE (OVER NEW YORK & NEW ENGLAND RAILROAD).**

This is a small wooden bridge. It was built in 1889, and is in good condition.

**BOYLSTON-STREET BRIDGE (IN BACK-BAY FENS).**

This is a stone-masonry bridge, and it was built in 1881-83. It is maintained by the Park Department. It is in good condition.

**BOYLSTON-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and it was built in 1886-88.

No repairs of importance have been made. The iron-work under the floor should be painted.

**\* BROADWAY BRIDGE (OVER FORT-POINT CHANNEL).**

This is an iron bridge. It was built in 1869-71, and the draw and its foundation were rebuilt in 1874-75.

The casting that carries the centre pin of the draw was found broken in May, and was repaired with wrought-iron hoops and wedges.

The centre pin and roller bearing was found to be in poor condition, and a new and simpler one has been made without rollers. It has not yet been placed in position. The bridge has been painted since August, 1889, and the iron-work is mostly in good condition as respects corrosion.

The spans over Foundry and Lehigh streets are weak structures, and the main trusses are more or less distorted. The 100-feet spans are of too light construction, and show great vibration under passing loads.

The concrete sidewalks have been repaired in part and are in fair condition.

The surviving experimental piece of asphalt roadway paving was removed in September, it being in bad condition. No work has been done upon the draw-pier.

**BROADWAY BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, was built in 1880-81, and is in good condition. The iron-work should be painted, as it is in bad condition, both above and below the floor.



**BROOKLINE-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, and was built in 1884. It is in good condition.

**BYRON-STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD).**

This is a wooden bridge, built in 1889. It is in good condition.

**\* CHARLES-RIVER BRIDGE (FROM BOSTON TO CHARLESTOWN).**

This is a wooden pile bridge with an iron draw. The original bridge was built in 1785-86, the present structure was built in 1854-55, and the draw was built in 1870.

The cross-bracing recommended last year has not yet been done. The bridge is old and poor, but has been used without serious delays to travel, and with only a moderate amount of repairs. The cross-bracing should be done at once. The paving should be patched and the timber-work of the draw put in good order.

**\*CHELSEA BRIDGE, SOUTH (OVER SOUTH CHANNEL, MYSTIC RIVER).**

This is a pile bridge with an iron draw. The original bridge was built in 1802-3, and the present structure in 1876-77.

The end bearings of the draw have been repaired and the latches adjusted so as to allow the draw to turn end for end and to be used in either position. The draw-piers have been planked, and the bridge, as a whole, is in good condition.

**\*CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

This wooden pile bridge was originally built in 1834, and was rebuilt in 1848; the present structure was built in 1873, and the draw was built in 1868.

Estimates were made for rebuilding this bridge last year. It is low, narrow, and inconvenient, and the draw and its foundation are in dangerous condition. Repairs have been made upon the draw to enable it to be turned off, but the draw and foundation, as a whole, are past repair.

**COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, was originally built in 1865, and the present structure was built in 1876-77.

The bridge has been stripped of wood-work, painted, and put in excellent condition. The telegraph-pole guys heretofore reported still remain.

**\*COMMERCIAL-POINT, OR TENEAN, BRIDGE (WARD 24).**

This is a wooden pile bridge with a wooden leaf draw. It was originally built in 1833, and the present structure was built in 1875.

It has been sheathed, and is in only fair condition.

**COMMONWEALTH-AVENUE BRIDGE (IN BACK-BAY FENS).**

This is an iron bridge, and it was built in 1881-82. The iron-work should be painted and the wood-work put in good condition.

**\*CONGRESS-STREET BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge with an iron turn-table draw on a stone-masonry foundation. It was built in 1874-75.

Steps have been provided for passing from the draw to the draw-pier without lifting a trap in the middle of the sidewalk floor, as has been done heretofore. The draw has been painted, new sidewalks have been laid, and the end bearings and latches have been put in order. The under-floor of the main bridge has been looked after and patched in many places, principally in the gutters, and it is now in fair condition. The fender-guard is in very bad condition and should be rebuilt.

**COTTAGE-STREET FOOT-BRIDGE (OVER FLATS, EAST BOSTON).**

This is a wooden pile bridge, built in 1889 for foot travel only.

It has been lighted during the summer months with electric lights, and it is in good condition.

**DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND BOSTON & PROVIDENCE RAILROADS).**

This is an iron bridge. It was originally built in 1869, and the present structure was built in 1878-79.

It was repaired and painted last year, and is in good condition.

**\*DOVER-STREET BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge with a double iron draw. It was originally built in 1805, was rebuilt in 1858-59, and the present structure was built in 1876.

The draws have been repaired and painted, new under-floors were laid, and the foundation timbers patched where decayed. The floor of the main bridge is known to be in poor condition in some places, and will soon require repairs.

**\*FEDERAL-STREET BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge with a double wooden draw. It was originally built in 1827-28; was rebuilt in 1857-58, and the present structure was built in 1872-73.

An appropriation of \$100,000 was made early in the year for rebuilding this bridge. Plans and specifications were prepared, and the work of rebuilding every part of the bridge except the two draws was let to Shaw & Miller, by contract dated July 23, for \$67,467.

The iron draws are to be furnished by the Pittsburg Bridge Company, by contract dated August 26. Contract price, \$10,218. Trucks are to be furnished by Charles Carr. The machinery for moving draw, the buildings, etc., are yet to be provided.

The bridge is to be of its present width, namely, 70 feet, and will be a wooden pile bridge with stone-block paving. Two sliding iron draws are to be built, together making up the full width of the street. The work is to be done one-half at a time, without closing the bridge to travel, and the first half is nearly ready to open at the present time. The width of the opening for vessels is to be 42 feet.

**FERDINAND-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1864-65, and was strengthened in 1877.

This bridge was partially stripped for repairs in July, and was found to be in so bad condition that the roadway and one sidewalk were closed, leaving one sidewalk only open for use. The work of building a new bridge has been let to R. F. Hawkins, of Springfield, for \$4,077.25.

**FRANKLIN-STREET FOOT-BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1883. It is in good condition.

**GOLD-STREET BRIDGE (OVER N.Y. & N.E. R.R.).**

See "Miscellaneous Work and Construction in 1890."

**HUNTINGTON-AVENUE BRIDGE (OVER BOSTON AND ALBANY RAILROAD).**

This is an iron bridge. It was built in 1872, and the abutments were rebuilt in 1876-77. It is in fair condition.

**LEYDEN-STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD.)**

This is a new iron bridge, built in 1889. The iron-work directly over the main tracks of the railroad is somewhat corroded, the paint used not having the protective qualities hoped for; otherwise the bridge is in good condition. It should be painted next year.

**LINDEN PARK-STREET BRIDGE (OVER STONY BROOK).**

This is a wooden truss bridge, built in 1886. It has been sheathed and the trusses adjusted. It is in good condition.

**\*MALDEN BRIDGE (FROM CHARLESTOWN TO EVERETT).**

The original bridge was built in 1787. The present structure was built in 1875, and the draw was built in 1872. It is a pile bridge, with a wooden turn-table draw on a pile foundation.

The draw was wrecked by a passing vessel in March. It was repaired, and has been in use as usual, but is old, narrow, and poor, and should be rebuilt. The fences, bulkheads, and wheel-guards on the fixed part of the bridge are decayed, and when the draw is rebuilt considerable repairs will be required on this portion of the bridge.

**\*MERIDIAN-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).**

This is a wooden pile bridge, with a wooden turn-table draw on a pile foundation. The original structure was built in 1856. It was rebuilt soon afterwards; it was widened

and rebuilt as at present in 1884, excepting the draw, which was built in 1875-76.

The draw has been repaired, new latches furnished and set, and several new angle-blocks put in the main trusses. Further repairs will be required, as the draw has nearly reached the limit of life of such structures. The fixed part of the bridge is in good condition.

**\*MT. WASHINGTON-AVENUE BRIDGE (OVER FORT-POINT CHANNEL).**

This is a wooden pile bridge with an iron draw. It was built in 1854, and was rebuilt in 1870-1.

The draw has been raised and new plates provided for the centre pin to turn upon. The sidewalks on the Boston side of the draw have been relaid with plank and newly concreted. The bridge is in fair condition.

**NEPTUNE-ROAD BRIDGE (OVER REVERE BEACH & LYNN RAILROAD IN EAST BOSTON).**

This is an iron bridge, and it was built in 1887-8.

It is maintained by the Park Department. It should be painted during the coming year; otherwise it is in good condition.

**NEWTON-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD.)**

This is an iron bridge, and was built in 1872.

It has been stripped, painted, new floors and sidewalks laid, and is in excellent condition.

**PUBLIC GARDEN FOOT-BRIDGE.**

This is an iron bridge. It was built in 1867, and was thoroughly repaired in 1887.

It should be painted during the coming year, and the floor should be relaid.

**SHAWMUT-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and it was built in 1871.

It was thoroughly overhauled last year, and is in good condition. The poles of the electric road have thrown the parapet out of line, and they should be reset in a different manner.

**SWETT-STREET BRIDGES (OVER SOUTH-BAY SLUICES).**

These are wooden bridges, and were built in 1875.

The pile bulkheads which serve as abutments to the easterly bridge have been repaired and made safe. The wings which retain the side slopes of the filled street are in bad condition, but it is not recommended that they be repaired. The wings of the westerly bridge are in similar condition, but the areas of water above each bridge are growing less as filling is made, and in a short time it is probable that the bridges will be replaced by smaller and more permanent waterways. In the mean time the abutments to the westerly bridge should be repaired, as they are in dangerous condition.

**\*WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).**

This is a wooden pile bridge with a double iron draw. It was originally built in 1828, and the present structure was built in 1883-4.

A new sidewalk has been laid on one draw, and the concrete sidewalk on the upstream side of the bridge has been resurfaced. The sidewalks on the other side should be repaired in a similar manner. The bridge as a whole is in good condition.

**WEST CHESTER-PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1876.  
It is in good condition.

**WEST CHESTER-PARK BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge, and it was built in 1876.  
It has been partly painted, and new floors to the sidewalks laid. It is in good condition.

**WEST RUTLAND-SQUARE FOOT-BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).**

This is an iron bridge. It was built in 1882. It is in good condition.

**WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP).**

This is a pile bridge without a draw. It was originally built in 1839, and was rebuilt in 1851, and was extensively repaired in 1870.

18.        **REPORT OF ENGINEERING DEPARTMENT.**

The sidewalk and adjoining fence have been rebuilt and the bridge sheathed. The bridge is old and poor, but is in safe condition.

**II. — BRIDGES OF WHICH BOSTON SUPPORTS  
THE PART WITHIN ITS LIMITS.**

**\*CAMBRIDGE-STREET BRIDGE (FROM BRIGHTON TO  
CAMBRIDGE).**

This is a wooden pile bridge with a wooden leaf draw. It was rebuilt in 1884.

The passageway for vessels has been widened from 30 ft. 8 in. to 36 ft., a new draw built, and the bridge on the Boston side of the channel widened from 31.6 ft. to 40 ft., and made to correspond with the width of the bridge in Cambridge, as nearly as practicable. The new draw is 28 ft. in width, and is a wooden lifting draw, raised by hand-power. The Cambridge part of the bridge, and the draw-pier maintained by Cambridge, have been rebuilt. The entire work was let in one contract, and has been done under the direction of the City Engineer of Cambridge. The amount to be paid the contractor by the City of Boston is \$2,066.27.

The part of the bridge maintained by Boston is in good order. The draw-pier needs new planking and a new cap-sill, and the face of the pier should be replanked.

**CENTRAL-AVENUE BRIDGE (OVER NEPONSET RIVER, DOR-  
CHESTER LOWER MILLS).**

This is an iron bridge, and was built in 1876.

New sidewalks have been laid on the part maintained by Boston. The wood-work on the whole bridge should be examined and put in good condition, and the iron-work painted.

**\*CHELSEA BRIDGE, NORTH (FROM MYSTIC-RIVER CORPORA-  
TION WHARF TO CHELSEA).**

The original structure was built in 1802-3; the present structure was built in 1880, except the draw, which was built in 1873.

The draw, and part of the bridge next the draw, has been repaired, but the draw is old and in poor condition. It must soon be rebuilt. The number of vessels passing through this bridge has largely increased on account of the construc-

tion of extensive wharves by the Boston & Maine Railroad, and will be still further increased as the improvements approach completion. It will be necessary to provide power to move the draw and to warp vessels through the bridge at an early day.

**\*ESSEX-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This is a wooden pile bridge with a wooden leaf draw, and was originally built in 1850.

A contract has been made with W. A. Kenrick & Son for widening the passageway for vessels from 30 ft. 11 in. to 36 ft., and for building a new draw. Contract price, \$7,000, one-half to be paid by the City of Cambridge; the work to be done under the direction of the City Engineer of Boston. The old draw, and all the old work included in the contract, has been taken down and a few piles driven at this date. Foot-travel is provided for by a temporary bridge.

The remaining part of the bridge is old and in poor condition; only ordinary repairs have been made upon it.

**\*GRANITE BRIDGE (FROM WARD 24 TO MILTON).**

This bridge was originally built in 1837. It is a wooden pile bridge with a wooden leaf draw.

The draw was rebuilt last year. The bridge is in good condition.

**LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOKLINE).**

The present structure was built in 1877. This is a wooden bridge on wooden posts set in the ground.

It has been extensively repaired, most of the stringers were renewed, new under and upper floors laid, and sidewalk rebuilt. A number of the wooden posts which carry the bridge have commenced to decay. The Boston half of the bridge is at the foot of a hill, and as large quantities of dirt are carried on to it by every rain, its usual condition is consequently unsightly.

**MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).**

This is an old iron bridge, and is in dangerous condition; one-half is maintained by the town of Milton. It should be rebuilt at once. It is favorably situated for building an inexpensive and permanent arched stone bridge.



**MILTON BRIDGE (FROM WARD 24 TO MILTON).**

The original structure is very old; it was widened in 1871-72. The older part of this bridge was built of stone, and the widening is an iron structure on stone columns.

No repairs of importance have been made. It should be painted and the wood-work carefully examined and put in good condition.

**\*NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).**

The original structure was built in 1802; the present structure, in 1877. This bridge is a wooden pile bridge with an iron leaf draw; both leaves of the draw are maintained by Boston.

The machinery for raising the draw has been repaired. The surface of the draw-piers should be replanked, and the face of the waterway patched. The iron draw should be painted.

**\*NORTH BEACON-STREET BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge with a wooden leaf draw. The original structure was built in 1822, and the present structure in 1884.

The draw has been planked and small repairs made. The bridge is in fair condition.

**\*NORTH HARVARD-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This bridge was originally built in 1662, and was rebuilt in 1879.

The opening for vessels has been made 36 feet in width, increasing it from 31 feet 8 inches, and a new draw 20.35 feet in width has been built. The new draw is in the same type as the old one; namely, a lifting or leaf draw, with hard-pine beams, raised by hand-power.

The down-stream draw-pier, which is maintained by the City of Boston, has been rebuilt in a new position with new oak piles and hard-pine timber; the plank on the face of the waterway is hard-pine, and the pier has a kyanized spruce deck. The new position of the pier made it necessary to dredge about 2,000 cubic yards of material from the bed of the river. There is now a good approach for vessels, making a great improvement over the former condition. Two bents of piles were taken up on the Boston side and

replaced with new; no new piles were driven on the Cambridge side. Means were provided for foot-passengers to cross during the rebuilding, but the bridge was closed to teams from October 22 to November 29.

The work is done under the direction of the City Engineer of Boston, the City of Cambridge paying one-half the cost. The contractors are John Cavanagh & Son; the contract price for the whole work is \$7,900.

The work is not yet completed, and no settlement has been made. The remaining part of the bridge, which is supported by Boston, is in fair condition. The abutment and the outlet of the sewer through it are in bad condition.

#### **SPRING-STREET BRIDGE (FROM WARD 23 TO DEDHAM).**

This is a stone bridge of five arches. The bridge is in good condition. The grade of the street has been raised until the railing is not high enough for safety. A new rail should be built.

#### **\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The original structure was built in 1824; the present structure was built in 1879-80.

The draw on this bridge, and on other similar bridges, is too heavily counterbalanced, and is very unsteady under passing teams. A new draw is to be built in the spring, and the waterway widened to 36 feet. By agreement the work is to be done under the direction of the City of Cambridge.

The draw-pier maintained by Boston needs replanking and new cap-sills.

#### **\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge. It was built in 1824; the present draw was built in 1883, and the abutment was rebuilt in 1886.

This bridge is exceedingly inconvenient for passing vessels, but is in fair condition.

### III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

#### ALBANY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

The original structure was built in 1856-57; was rebuilt in 1867-68, and again in 1886-87. It is an iron bridge. It should be painted next season. The abutments, which were rebuilt in 1886-87, have stood perfectly and show no cracks.

#### \*CANAL BRIDGE (FROM BOSTON TO CAMBRIDGE).

#### \*PRISON-POINT BRIDGE (FROM CHARLESTOWN TO CAMBRIDGE).

#### \*WEST BOSTON BRIDGE (FROM BOSTON TO CAMBRIDGE).

These bridges are in the care of two Commissioners, appointed, one from Boston and one from Cambridge, and the expense of maintenance is borne equally by each city. The Boston Commissioner makes an annual report in print.

Canal bridge is a wooden pile bridge with a wooden turn-table draw. The bridge was originally built in 1808; was rebuilt in 1852, and again rebuilt and widened in 1874; some of the piles in this bridge date from 1808.

The roadway paving has been relaid and the edgestones reset on the greater part of the bridge. This gave an opportunity to examine the wooden flooring under the paving, and it was found to be generally in fair condition; a part of the side bulkhead, about three hundred feet in length, has been rebuilt, and portions of the brick sidewalk have been relaid. The draw and fences have been painted. The fender-guard on the upstream side of the bridge is in bad condition, and the sides of the passageway for vessels are in need of replanking.

Prison-point bridge was originally built in 1833, and the present structure was built in 1876-77. It is a wooden pile bridge with an iron leaf draw.

No repairs of importance have been made. The draw-pier needs replanking; otherwise the bridge is in fair condition.

West Boston bridge was built in 1792-93, was rebuilt in 1854, and repaired in 1871; the draw was rebuilt in 1875. It is a wooden pile bridge with a wooden turn-table draw.

The widening contemplated in the act of the Legislature of 1889 has not been made, and there is no immediate prospect of its being done. It will be necessary to make the repairs to the southerly side of the bridge from the draw to the Cambridge abutment (which has been delayed on account of the proposed widening during the coming year), as this part of the bridge is in a dangerous condition.

Only ordinary repairs have been made during the year, the paving is in bad order, and the general condition of the bridge was described as follows in the last annual report: "As a whole, the bridge is old, narrow, and poor. It is no wider than it was in 1854, and the travel over it has greatly changed and increased, and is now very large. The draw, built in 1875, has almost reached the limit of life for a wooden structure of its character. It will be necessary to rebuild the entire bridge before many years."

#### DORCHESTER-STREET BRIDGE (OVER OLD COLONY RAILROAD).

This is an iron bridge; it was built in 1869.

The bridge has not been stripped and painted for ten years. It is known to be in bad condition, just how bad cannot be ascertained without removing all the wood-work. It should be thoroughly overhauled in the spring.

#### \*HARVARD BRIDGE (FROM BOSTON TO CAMBRIDGE).

This is still in the hands of the commission, and is not open to travel, owing to legal complications, although it has been practically completed for more than a year.

### IV. — BRIDGES SURPORTED BY RAILROADS.

#### WASHINGTON-STREET BRIDGE (OVER THE BOSTON AND ALBANY RAILROAD).

This bridge was partially stripped for repairs, and found to be in even worse condition than was suspected. It is understood that a contract has been made for the immediate erection of a new bridge.

The two Norfolk-street bridges in Dorchester, reported last year in poor condition, have not been repaired, and still remain in bad condition.

Savin Hill-avenue bridge, over the Old Colony Railroad in Dorchester, is old and poor. Estimates have been made for building a new bridge for the accommodation of both

the city and the railroad, the new bridge to be wider than at present, and long enough to span four railroad tracks; the expense to the city to be about \$5,000.

The other bridges given in the list of those supported by railroad corporations require no special mention.

### MISCELLANEOUS WORK AND CONSTRUCTION IN 1890.

#### GOLD-STREET BRIDGE (OVER N.Y. & N.E. R.R.).

This is a wooden foot-bridge over the railroad at Gold street, South Boston. It was built for the Street Department by Jos. P. Shaw, at a cost of \$578.50.

The work was done under the direction of this department, by which the plans and specifications for the bridge were prepared.

#### FERDINAND-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

Plans and specifications for a new iron bridge have been prepared, and the contract for the same has been awarded to R. F. Hawkins, of Springfield, Mass.

In view of the possible future widening of Ferdinand street to 50 feet, it was thought best to provide for such widening in the design of the new bridge.

The new bridge, which is to be the present width of the street, is to have one roadway and two sidewalks, as shown in cross-section in Fig. 1 on the accompanying plate. In case the bridge is to be widened to 50 feet, the sidewalks will be removed, the main girders A and B and floor-beams between them utilized, girder C and floor-beams for one-half of bridge added, and wood-work remodelled and provided all as shown in Fig. 2.

#### EAST BOSTON FERRIES.

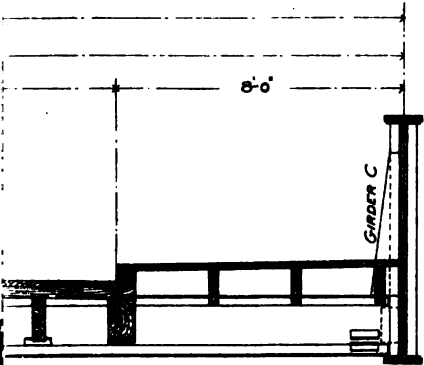
Plans, specifications, and form of contract were furnished at the request of the Ferry Commissioners, for taking down a wall and building foundation for pile wharf at the North Ferry, East Boston. The work was done under the supervision of the Ferry Department.

An examination of a damaged drop was made, and a report and recommendation presented to the commission. The repairs were made under the supervision of this department.

ALBANY RAILROAD.



SCALE OF FEET.



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Plans, specifications, and form of contract have been made for rebuilding a part of the ferry-slip at East Boston, North Ferry. The work has been let to J. N. Hayes & Co., for \$7,500. The only work yet done has been the removal of the old pier.

#### BULKHEAD ON L STREET, SOUTH BOSTON.

At the request of the Street Department, plans and specifications have been prepared for building a bulkhead on L street, South Boston, in extension of that built last year. The additional length enclosed is 328½ feet, and will extend the street nearly to the reserved channel. The work has been let to F. G. Whitcomb for \$7,200. No work has yet been done on the contract.

#### ASPHALT WALK ON COMMON.

The asphalt tile walk on the Common, from the West-street entrance to Charles street, was laid under the superintendence of this department. The work of laying was done by John Turner & Co., at a cost of \$4,844. The tiles used were furnished by the Hastings Pavement Co.

#### COMMONWEALTH-AVENUE WIDENING.

Estimates have been made for the Superintendent of Streets, of the filling deposited on Commonwealth-avenue widening by E. V. Foote, contractor.

Other work, of a miscellaneous character, was principally as follows :—

#### PLANS AND SPECIFICATIONS.

For gates and flooring, dam at Lake Cochituate.  
athletic apparatus for women, Charlesbank.  
Ferdinand-street bridge.  
boilers for Mystic Pumping-Station.

#### PLANS AND ESTIMATES.

For filling at George, Shirley, and Langdon streets.

#### PLANS.

For repairing centre, Mt. Washington-avenue draw.  
new centre, Broadway draw.  
fence at boat-landing, Charlesbank.  
float at Parker-Hill reservoir.



## ESTIMATES.

For filling proposed sewer-yard, North Brighton.

For bridge and abutments, Bernard street and Lauriat avenue.

For retaining-walls on Follen street, Harcourt street, Clarendon street, and Stanhope street.

For bridge at Savin Hill.

For abolition of grade crossings at Tremont street, Forest Hills, Dover street, Dorchester avenue, Congress street, First street, A street, and at streets crossing Providence division of Old Colony Railroad.

A large amount of miscellaneous office-work has also been done, such as making record plans, maps for Water and Park Departments, and copying, tracing, and blue-printing plans.

## B. — WATER-WORKS.

[FROM THE CITY ENGINEER'S REPORT TO THE BOSTON  
WATER BOARD.]

## SOURCES OF SUPPLY.

The rainfall during the past year has been more than the average amount, but has been unequally distributed.

During June, July, and August the rainfall was small, and the yield of the water-sheds was reduced to so small an amount as to cause fears of a drought.

The rainfall in September and October was large, — that of October being greater than in any one month since July, 1867, and the supply of water has been abundant during the latter part of the year.

The rainfall and quantities collected on the several water-sheds are as follows : —

	Sudbury.	Cochituate.	Mystic.
Rainfall, inches .	53.00	51.23	49.37
Rainfall collected , inches . . .	26.998	24.51	26.04
Daily average yield in gallons . . .	96,658,100	22,023,100	33,323,300

The quality of the Sudbury and Cochituate waters has been good, and the quality of the Mystic water has been equal to the usual average from that supply.

The fluctuations in the amount of water in the different lakes and reservoirs is shown graphically by an appended diagram.

The condition of the different reservoirs during the year is given below : —

## SUDBURY-RIVER RESERVOIRS AND LAKE COCHITUATE.

*Reservoir No. 1.* — Water was wasting at the outlet dam from January 1 to July 6, with the exception of two days in June, after the stop-planks were placed on the dam. Water was also wasting from September 12 to September 21 ; from September 24 to September 25 ; and from October 4 to the present time.

The dam at Reservoir No. 1 is in good condition.

*Reservoir No. 2.* — This reservoir was full until the latter part of June, with the exception of a short time in March, when the reservoirs were drawn down in anticipation of the usual large spring flow in the river.

During July the storage was reduced until the 25th, when the surface was at grade 160.30, or 5.57 feet below the crest of the dam. In the latter part of August the reservoir began to fill, and from October 7 till the present time, water has been running over the dam.

The dam at Reservoir No. 2 is in good condition.

*Reservoir No. 3.* — This reservoir was drawn down 3.75 feet in the early part of March, but soon refilled, and water was running over the crest of the dam until July 9. The lowest point reached during the summer was on August 17 when the surface was 1.25 feet below the crest of the dam. Water has been flowing over the dam since September 13.

The dam at Reservoir No. 3 is in good condition.

*Reservoir No. 4.* — This reservoir was drawn down about 3 feet in March, but had refilled on March 25, and remained full until July 9.

From that date the surface fell until September 13, when it was 13.07 feet below the crest of the dam. From the latter date the reservoir began to fill, and had risen to the crest of the dam on December 18. The dam at Reservoir No. 4 is in good condition.

*Farm Pond.* — The surface of the pond has been kept at an average height of 149.33 feet above tide marsh level.

The conduit through the pond has been used all the year, excepting from March 21 to April 5, and from November 5 to December 14, when the water sent to Chestnut Hill was drawn through the pond.

The Framingham Water Co. have pumped 74,500,000 from the pond, or an average of 204,000 gallons per day.

*Lake Cochituate.* — Water was wasting at the outlet dam during January, February, and March, and a part of April and May. On June 1 the surface was 0.39 feet below high-water mark, when the supply for the city began to gradually lower the water until September 12, when the surface was 5.19 feet below high-water mark.

During the latter part of October the lake filled rapidly, and water was allowed to waste at the outlet dam from Dec. 18 to Dec. 26.

The dam at Lake Cochituate is in good condition.

The heights of water in the various storage reservoirs on the first day of each month are given below.

	RESERVOIRS.				FARM POND.	LAKE COCHITU- ATE.
	No. 1.	No. 2.	No. 3.	No. 4.		
	Top of flash- boards. 169.29	Top of flash- boards. 167.12	Crest of Dam. 175.24	Top of flash- boards. 215.21	High Water. 149.25	Top of flash- boards. 134.36
January 1, 1890 . . . . .	157.95	166.14	175.52	214.56	149.60	132.77
February 1, " . . . . .	157.88	166.04	175.48	214.51	149.10	132.30
March 1, " . . . . .	158.18	166.30	175.70	214.68	149.48	132.60
April 1, " . . . . .	158.34	166.11	175.60	214.76	149.09	132.75
May 1, " . . . . .	157.95	166.14	175.51	214.53	149.41	133.38
June 1, " . . . . .	157.89	167.26	175.54	214.49	149.69	133.97
July 1, " . . . . .	159.31	166.43	175.31	214.93	149.40	132.92
August 1, " . . . . .	158.92	169.90	174.74	211.79	149.01	131.19
September 1, " . . . . .	158.57	161.66	174.48	204.51	148.81	129.57
October 1, " . . . . .	156.98	164.07	175.35	202.58	149.17	129.46
November 1, " . . . . .	158.19	166.23	175.37	210.75	149.12	132.37
December 1, " . . . . .	157.76	166.04	175.49	213.86	149.34	132.45
January 1, 1891 . . . . .	157.66	165.96	175.32	214.41	149.36	132.49

Water has been drawn from the different reservoirs on the Sudbury river to supply the city, as follows :—

#### RESERVOIR NO. 1, AND FARM POND.

Nov. 5 to Dec. 14.

#### RESERVOIR NO. 2.

Jan. 3 to Jan. 10.

May 14 to June 8.

June 11 to July 27.

Aug. 7 to Sept. 24.

Sept. 26 to Nov. 4.

#### RESERVOIRS NOS. 2 AND 3.

Jan. 1 to Jan. 2.

Jan. 11 to Jan. 13.

Jan. 17 to Jan. 20.

Jan. 24 to Jan. 27.

Jan. 31 to Feb. 3.

Feb. 7 to Feb. 10.

Feb. 14 to Feb. 17.

Feb. 21 to Feb. 24.

Feb. 28 to Mar. 3.

Mar. 7 to Mar. 10.

Mar. 14 to Mar. 17.

Mar. 21 to Mar. 24.

Mar. 28 to Mar. 31.

April 4 to April 7.

April 11 to April 14.

April 18 to April 21.

April 25 to May 13.

July 28 to Aug. 6.

Dec. 17 to Dec. 21.

Dec. 23 to Dec. 28.

Dec. 31.

### AQUEDUCTS AND DISTRIBUTING RESERVOIRS.

The Sudbury-river aqueduct has been used 311 days, and the Cochituate has been used 355 days.

The Sudbury conduit has delivered 6,596,000,000 gallons into Chestnut-hill and Brookline reservoirs, equal to a daily supply of 18,071,200 gallons; the Cochituate aqueduct has delivered 5,722,170,800 gallons, or 15,677,200 gallons per day.

In the Cochituate aqueduct a flow  $6\frac{1}{2}$  feet in depth was maintained during the year. The rate of flow in the Sudbury conduit was varied from day to day as was necessary to keep the distributing reservoirs at the proper height.

Both aqueducts have been cleaned as usual during the year.

The Chestnut-hill, Brookline, Fisher-hill, Parker-hill, and East Boston reservoirs, and the Bellevue and Breed's Island water-towers, are in good condition.

### HIGH-SERVICE PUMPING-STATIONS.

At the Chestnut-Hill station the pumping-engines and boilers are in good condition.

The feed-water heater was thrown out of service from April 15 to October 17 on account of the brass tubes in the heater having been destroyed by the gases in the smoke flue.

The heater was repaired by substituting galvanized wrought-iron tubes for the old brass tubes.

The duty of the boilers was reduced about 5 per cent. when the heater was not in use.

A storage battery has been connected with the electric-lighting plant to furnish lights for the station and biological laboratory during the daytime, or when the dynamo is not running. Two arc lights have been connected with the incandescent circuits, one being hung over each engine.

One of the Standard Themometer Co.'s electric gauges was placed in the engine-room in June to indicate and register the heights of water in Fisher-hill reservoir.

A boiler trial was made on December 4 and 5 to verify the results indicated by the daily records and to check the feed-water meters.

The trial was conducted under the same conditions as are met with during the daily runs, with the exception of carefully weighing the water before it was pumped into the boiler. To do this it was necessary to convey the feed-water, including that from the steam jackets and radiators, to a

weighing barrel, instead of passing it directly into the boiler.

On December 4 the pumping-engine was run till 7 A.M., when the steam in the boiler had fallen from 70 to 42.5 lbs., no coal having been fed to the furnaces during the previous half-hour. The fires were then cleaned and lightly banked with 250 lbs. of coal.

The connections in the feed-water pipes were then changed so the water fed to the boiler could be weighed, and at 9 A.M. the engine again started, the steam pressure having been raised to seventy pounds.

The height of the water in the boiler was carefully marked at 7 A.M., and was left at the same point at the end of the trial.

Duration of trial, including two hours banking,	24 hours
Average steam pressure . . . . .	70.18 lbs.
“ temperature feed-water before heating,	75.6°
“ “ “ after “ . . . . .	114.2°
“ “ of flue front of heater . . . . .	358°
“ “ “ “ back “ “ . . . . .	198°
Total coal used . . . . .	8,716.5 lbs.
“ ashes removed . . . . .	620.5 “
“ combustible . . . . .	8,096. “
“ weight of water fed to boiler . . . . .	90,015 “
Water evaporated per lb. of coal, actual . . . . .	10.33 “
“ “ “ “ combustible . . . . .	11.12 “
Equivalent evaporation per lb. coal, from and at 212°, including feed-water heater . . . . .	12.14 “
Equivalent evaporation excluding feed-water heater . . . . .	11.42 “
Equivalent evaporation per lb. combustible, from and at 212°, including feed-water heater, . . . . .	13.07 “
Equivalent evaporation per lb. combustible, from and at 212°, excluding feed-water heater, . . . . .	12.30 “
Coal burnt per sq. foot, grate surface, during pumping . . . . .	10.00 “
Per cent. ashes and clinkers . . . . .	7.12 “

The table on page 40 shows the work done by the pumping-engines and boilers during the year.

Engine No. 1 was used 3,466 hours,	
pumping . . . . .	1,208,902,600 gals.
Engine No. 2 was used 3,344 hours,	
pumping . . . . .	1,160,729,100 “
Total amount pumped . . . . .	2,369,631,700 “
“ “ coal consumed . . . . .	2,677,281 lbs.

Per cent. ashes and clinkers . . .	8.2
Average lift in feet . . . . .	123.16 ft.
Quantity pumped per lb. of coal . . .	885.1 gals.
Daily average amount pumped . . .	6,492,100 "

The amount pumped is an increase of 10.5 per cent. over that of 1889.

The same boiler supplied the steam for pumping, and for heating and lighting the pumping-station and other buildings near the station.

#### COST OF PUMPING.

Salaries . . . . .	\$9,000 75
Fuel . . . . .	5,845 08
Repairs . . . . .	2,013 24
Oil, waste, and packing . . . . .	741 80
Small supplies . . . . .	424 08
<b>Total . . . . .</b>	<b>\$18,024 95</b>
Cost per million gallons raised one foot high . . .	\$0.0618
" " " pumped to reservoir . . .	\$7.61

At the West Roxbury pumping-station 14,313,800 gallons have been pumped, equivalent to a daily average of 39,200 gallons, or an increase of 10.9 per cent. over 1889.

At the East Boston pumping-station an average of 8,000 gallons per day have been pumped to the Breed's Island water-tower.

Water has been pumped into the East Boston reservoir only on one day in January, one day in February, one day in March, and two days in December, as the reservoir was filled during the night from the low-service main during the balance of the year.

This favorable showing is owing to the mild weather during last winter.

#### MYSTIC LAKE.

Water was wasting over the dam during the first half of the year with the exception of six days in June. On July 1 the surface of the lake began to fall, and on September 10 was at grade 3.02, or 3.98 feet below high-water mark, the lowest point reached during the year. From this date the lake began to fill, and water has been running over the dam from October 20 to the present time.

## MYSTIC VALLEY SEWER.

The pump has been run on 335 days, working 5,147 hours, and has pumped 119,119,670 gallons of sewage, or an average of 355,500 gallons per day of pumping.

The total amount pumped is 19% more than during 1889. The increase being due to the increased time of running the pumps.

The total amount of sulphate of alumina used during the year was 323,650 pounds, and 191 tons of coal were used in pumping.

## MYSTIC CONDUIT AND RESERVOIR.

The conduit was cleaned during the year, and is in good condition.

The reservoir has not been cleaned during the year, but has received the usual care.

## MYSTIC PUMPING-STATION.

Three new boilers have been placed in the boiler-room, and the four old boilers that have been in use since 1872 were taken out.

The new boilers were built by the Roberts Iron Company, of Cambridgeport, from designs made in this office. They are similar in size and design to the three other boilers that were built six years ago. They are 78 inches in diameter, 17 feet in length, and each boiler contains 151 tubes of 3 inches outside diameter. The boiler shells are of  $\frac{7}{8}$  inch steel, and the tube-sheets of  $\frac{1}{2}$  inch steel.

The "Jones Economic Furnace" was connected with the three older boilers in April, and the same attachment has been placed under the new boilers.

The new boilers were first used on November 6.

An independent air-pump and condenser has been connected with the two 5,000,000 pumps, and the old condensers and air-pumps, which had become badly worn, were abandoned.

A combined dynamo and water motor, furnished by the Belknap Water Motor Co., of Portland, has been placed in the engine-room, and the buildings have been wired for sixty-six incandescent lights. The dynamo has a nominal capacity of only thirty lights, but the pipe connections to the motor were made large enough to supply power for a larger plant, if the plant should prove to be a success.

The table on page 50 shows the work done by the pumping-engines during the year.



Engine No. 1 was in use 430 hours, pumping . . . . .	77,644,200 gallons
Engine No. 2 was in use 1,426 hours, 15 minutes, pumping .	270,667,500 "
Engine No. 3 was in use 8,355 hours, 45 minutes, pumping .	2,681,804,800 "
Total amount pumped . . . . .	3,030,116,500 "
Total amount of coal consumed .	6,506,000 lbs.
Percentage ashes and clinkers .	9.8
Average lift in feet . . . . .	147.11
Quantity pumped per lb. of coal .	465.7 gallons
Average duty of engines, per 100 lbs. of coal, no deductions .	57,141,800 ft.-lbs.
Daily average amount pumped .	8,301,700 gallons

## COST OF PUMPING.

Salaries . . . . .	\$9,544.50
Fuel . . . . .	12,686.25
Repairs (not including new air-pump and boilers) . . . . .	403.52
Oil, waste, and packing . . . . .	532.28
Small supplies . . . . .	340.53
Total . . . . .	<hr/> \$23,507.08
Cost per million gallons raised one foot high,	\$0.0528
Cost per million gallons pumped to reser- voir . . . . .	\$7.76

## CONSUMPTION.

The daily average consumption from the combined works, and the consumption compared with that of 1889, has been as follows : —

1890.	COCHITUATE WATER.		MYSTIC WORKS.		COMBINED SUPPLY.	
	Consumption in Gallons.	Percentage of Consumption of 1889.	Consumption in Gallons.	Percentage of Consumption of 1889.	Consumption in Gallons.	Percentage of Consumption of 1889.
January . . . . .	33,680,000	111.6	8,187,900	105.4	41,867,900	110.3
February . . . . .	33,080,700	92.1	8,299,700	91.5	41,380,400	92.0
March . . . . .	30,844,400	95.8	8,055,900	106.9	38,900,200	97.9
April . . . . .	30,466,600	98.9	7,481,600	104.1	37,948,200	99.9
May . . . . .	31,381,200	95.9	7,488,400	97.7	38,869,600	96.3
June . . . . .	33,022,700	98.9	8,896,000	104.7	41,918,700	100.1
July . . . . .	36,701,100	115.2	9,463,300	113.8	46,164,400	114.9
August . . . . .	36,316,000	115.6	8,932,200	110.1	45,248,200	114.5
September . . . . .	36,165,800	114.0	8,486,700	106.9	44,652,500	112.4
October . . . . .	33,388,900	105.5	7,784,100	102.1	41,173,000	104.7
November . . . . .	32,955,100	104.5	7,601,300	103.9	40,556,400	104.4
December . . . . .	38,334,100	120.4	9,448,300	126.4	47,782,400	121.6
Average . . . . .	33,871,700	105.6	8,301,400	106.0	42,173,100	105.7

The daily average consumption per head of population has been as follows : —

Sudbury and Cochituate supply . . . . .	82.5 gallons
Mystic supply . . . . .	70.6 “
Combined supplies . . . . .	79.8 “

The above figures show an increase of 5.6 per cent. in the consumption from the Sudbury and Cochituate works from that of the previous year, of 6 per cent. in the consumption from the Mystic works, and of 5.7 per cent. increase in the consumption from the combined supplies.

#### DISTRIBUTION.

The following changes were made in the distribution system during the year : —

SIZE.	SUDBURY AND COCHITUATE WORKS.		MYSTIC WORKS IN CHARLESTOWN.	
	Total length laid and relaid.	Length abandoned.	Total length laid and relaid.	Length abandoned.
3"	.....	.....	.....	988
4"	1,516	1,145	1,416	2,489
6	41,416	4,121	4,693	421
8"	11,561	261	98	
10"	5,791	.....	799	
12"	36,349			
16"	823	198		
20"	221			
24"	8,158			
Total length.	105,835	5,725	7,006	3,898

The total length of pipe laid on the Sudbury and Cochituate division was twenty miles, and a little over one mile has been abandoned, making a net increase of nineteen miles in the total length in use.

On the Mystic works in Charlestown the mains were extended 1,792 feet; 1,316 feet of 1-inch and 2-inch service-pipes were relaid with 4 and 6-inch main pipes, and 3,898 feet of 3, 4, and 6-inch wrought-iron and cement pipes were replaced with cast-iron pipes.

On the Cochituate division a new high-service main, 24 inches in diameter, was laid from the 30-inch main in Perkins street to Forest hills.

This pipe is 8,150 feet in length, and should soon be extended to the vicinity of Roslindale.

The high service has been extended to supply a portion of Savin Hill, and over two miles of high-service pipes have been laid in the City proper, to supply fire-pipes and sprinklers inside of buildings.

The Bellevue high-service pipes have been extended to connect with the pipe in Pond street, west of May street, in Jamaica Plain, as there were several houses in that district that could not be supplied from Fisher-hill reservoir.

About one mile of main pipes have been relaid with larger pipes to improve the fire service in the City proper.

## ADDITIONAL SUPPLY.

The borings, which were commenced last year to determine the location and character of the proposed dam, were completed early in the year and a site for the dam was chosen about 360 feet up-stream from the preliminary location.

Plans were made and surveys continued so that work was commenced in April, and has been continued through the season.

In accordance with your vote of July 8, 1890, "That the Engineer be authorized to engage the services of Mr. Jos. P. Davis as consulting engineer for the new dam and reservoir No. 5 and Cedar swamp," Mr. Davis was engaged as consulting engineer, and the following is his report on the new dam:—

NEW YORK, Aug. 21, 1890.

MR. WILLIAM JACKSON, *City Engineer, Boston, Mass.*:—

At your request I have visited the site and examined the plans of Dam No. 5, of the Sudbury River Water-Works, and now present my views on the points to which you have called my attention.

The location of the dam appears to have been well selected, as the core-wall can be founded upon ledge rock throughout its whole length without excessive excavation.

This rock, where uncovered, though, in general, sound and firm, is somewhat broken up by shrinkage cracks that probably will permit some water to flow under the dam unless by puddling or other device it can be prevented from reaching the base of the core-wall.

From the trials that have been made, and from the general appearance of the surface, it is not probable that rock much freer from fissures would be found by excavating a few feet into the ledge; I would therefore advise that it be removed only where found decayed or unfit to support the wall.

Of course you will take great care to select the best materials for filling the trench in front of the wall, and to have them thoroughly puddled and rammed, and the puddle firmly bonded to the side of the trench, that access of water to the bed rock at this point may be prevented as far as possible.

With this precaution, and the closing of wide cracks with cement grout, I am of opinion that there will be no troublesome leakage, certainly none that can endanger the dam.

I approve the form and dimensions of the cross-section of the dam and its core-wall, but would recommend that the

latter be built at least one foot higher than shown on the plan, or fully to elevation 298.

I also approve the proposed method of protecting the slopes of the dam and the location and dimensions of the wasteway, and of the tail race, as the latter are outlined in the letter of Mr. FitzGerald which you forwarded to me with the plans.

Your respectfully,

(Signed)

JOS. P. DAVIS.

When the trench for the core-wall was excavated, it was found, at the southerly end, to be in a very compact material, practically water-tight, and it was deemed useless to carry the excavation to solid rock. Consequently, after consulting with Mr. Davis, the plan of the core-wall at this point was modified.

The accompanying plates are views of the work of construction at Dam No. 5.

A survey for the improvement of Cedar swamp was commenced, and will be continued during the winter, as much of the work can only be done when the swamp is frozen.

The survey of Whitehall pond and its vicinity has been completed.

For particulars see the following report of Desmond FitzGerald, Resident Engineer.

#### OFFICE OF ADDITIONAL SUPPLY.

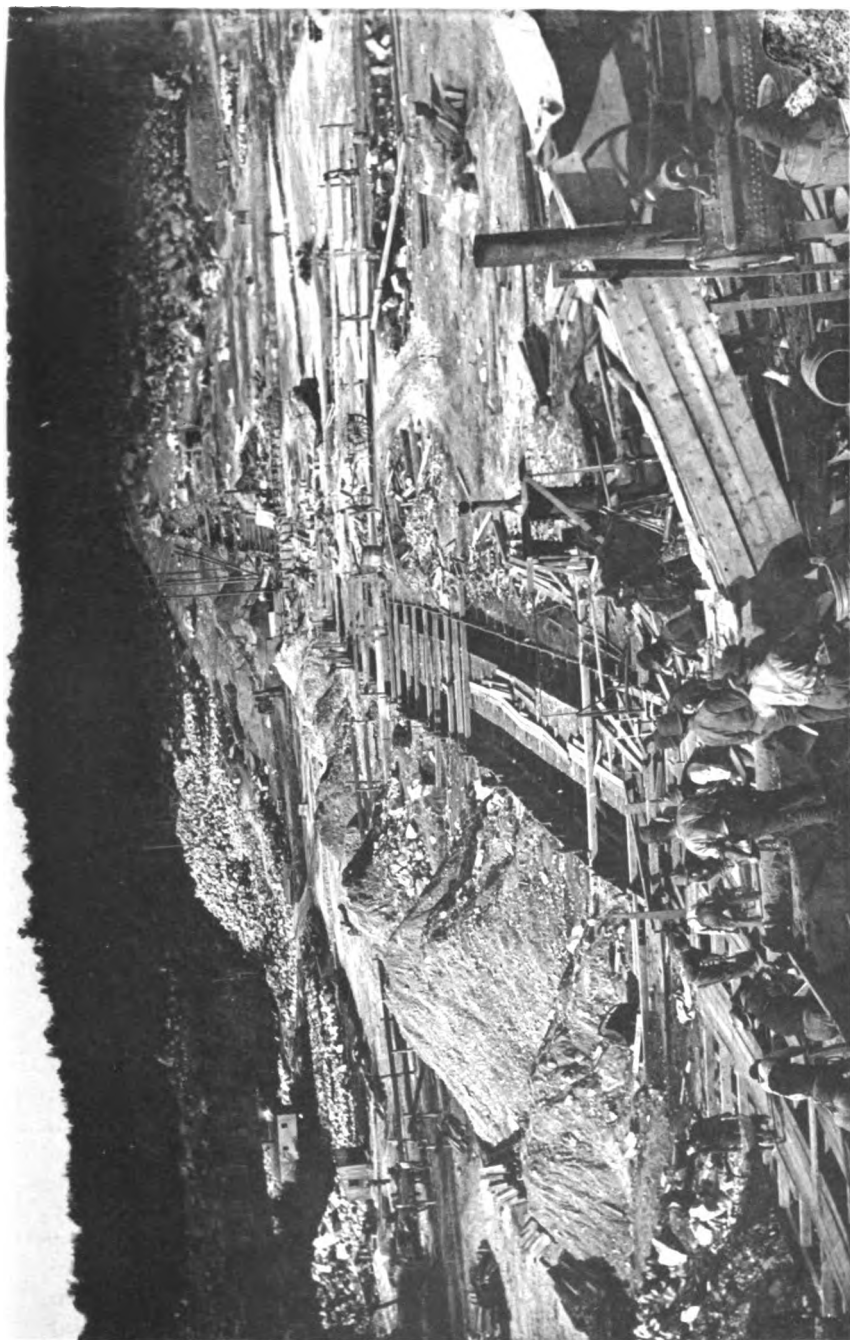
SOUTH FRAMINGHAM, MASS., Jan. 1, 1891.

WILLIAM JACKSON, Esq., *City Engineer, etc.*:—

SIR, — I submit herewith a brief report of engineering work accomplished during the past year by the "Additional Supply" force.

In January, 1890, a filtration field for the disposition of the Marlboro' sewage was found, lines run, and estimates made on the increased cost resulting to the town from carrying its sewage entirely outside of the drainage area feeding the Boston Water Supply system. The South Framingham filtration field, for the disposal of the sewage which formerly found its way into Farm pond and Lake Cochituate, has been in successful operation during the year.

Active operations have been carried on at Basin 5 during the past season. During the months of January, February, and March, diamond drill borings were put down on three lines for the dam, and as a result, the old site was abandoned for a situation about 300 feet farther up-stream. On April 15, stripping on the site of the dam was started,



HELIO TYPE PRINTING CO.,

DAM NO. 5.—VIEW OF SITE OF DAM.

BOSTON, MASS.





BOSTON, MASS.

DAM NO. 5.—VIEW OF BOTTOM OF TRENCH OF CORE WALL.

HELIOTYPE PRINTING CO.





and on the first of June the excavating for the core-wall was begun. On June 24 the bed rock was reached in the first section. On August 7 the concrete wall was begun. In May a water-works system was devised for delivering water under pressure at any point of the dam during its construction. The work was pushed during the remainder of the season until stopped by frost.

The trench is practically completed and the core-wall built across the valley to the surface of the ground. The following table shows the quantities of materials moved during the year :—

Soil stripping . . . . .	27,037 cu. yds.
Rock . . . . .	2,125 “
Trench excavations . . . . .	20,464 “
Concrete . . . . .	7,178 “
Embankment . . . . .	5,370 “
Stripping in basin . . . . .	18,700 “

The roads around the basin have been built by Newell & Snawling, under their contract of May, 1890. Specifications have been prepared for delivering filling upon the dam. Gaugings of the flow of Indian brook and from Whitehall pond have been observed during the year.

Plans have been prepared for the “taking” of the necessary lands around Whitehall pond, and whenever the engineering force could be spared from Basin 5, surveys have been made of the Cedar Swamp District.

The experiments on filtration, begun early in the year, have been unremittingly continued at Chestnut-hill Reservoir. Continuous and intermittent filtration have been carried on side by side and the results closely examined in the biological laboratory and chemically by Dr. T. M. Drown. It is too early to arrive at definite conclusions in regard to this work. Experiments of a different nature from any already made have been conducted, and as they are carried on entirely with the Boston water, we shall be able to know the exact effects of filtration under different conditions on our water supply.

The work of lining the Beacon-street tunnel with concrete was abandoned on April 18 for lack of funds. About 563 feet of lining was completed. The following table shows the cost of laying concrete in the tunnel :—

Crushing stone . . . . .	\$1 00 per cu. yd.
Carting crushed stone . . . . .	09 " "
Quarrying stone . . . . .	92 " "
Screenings . . . . .	25 " "
Sand . . . . .	31 " "
Screening sand and gravel . . . . .	49 " "
Transporting materials . . . . .	2 35 " "
Preparing bottom . . . . .	83 " "
Cement . . . . .	3 30 " "
Mixing and laying . . . . .	4 24 " "
Forms . . . . .	94 " "
Holidays . . . . .	30 " "

---

Total . . . . . \$15 02 " "

Both Rosendale and Portland cement were used.

Very respectfully yours,

(Signed)

DESMOND FITZGERALD,  
*Resident Engineer.*

#### IN GENERAL.

The new dam at the outlet of Lake Cochituate has been completed, but much work remains to be done in grading the adjacent grounds and removing the old dams; this work may, however, be done from time to time as funds may be available.

Plans have been prepared for a 20,000,000-gallon high-duty pumping-engine for the high-service pumping-station at Chestnut-hill Reservoir; they will soon be completed.

The work of lining the Beacon-street tunnel, which was stopped in April, has been recommenced, and should be continued as far as means are available.

The disposal of the sewage from the several towns in the water-shed has received considerable attention. The Framingham sewer system has worked satisfactorily, excepting the discharge from an under drain used during the construction of the sewer, which empties into a feeder of Lake Cochituate.

The Marlboro' sewer system is in process of construction, and should be completed and in use during this year. Plans have been made by Charles A. Allen, civil engineer, of a sewerage system for the town of Westboro', and surveys are now being made to determine the sum it would be proper for the city to pay the town by reason of extra expense to it for conveying its sewage outside of the limits of the city's water supply.

The experiments in filtration started last year at Chestnut-

The experiments in filtration started last year at Chestnut-hill Reservoir have been continued. The results so far obtained indicate, as was expected, that different waters are not alike affected by filtration, and, consequently, a small filtration plant has been established on the Mystic Water-Works.

The pipe for a 30-inch main from Tremont street through East Chester park and Swett street to Dorchester avenue has been contracted for, and will be laid the coming season. This main has been rendered necessary on account of the increased consumption of water in South Boston and Dorchester.

Forty contracts for rock excavations have been made during the year.

Two hundred and seventy-five petitions for main-pipe extensions have been received and reported upon in regard to grade of street, size of pipe, and cost of laying.

The pipe laid has been measured, the gates and hydrants located, and are being plotted on the plans.

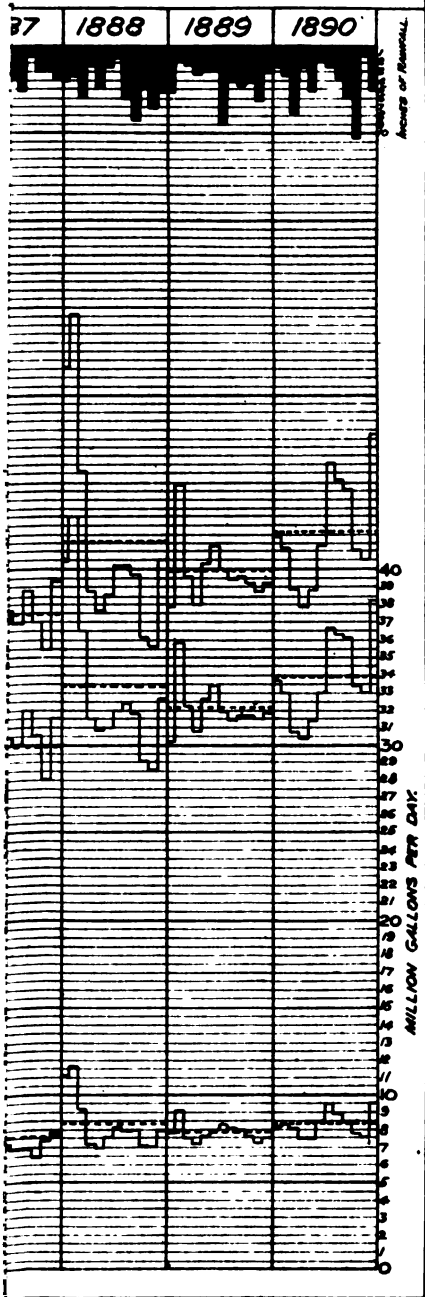
Sixty-one profiles of unaccepted streets have been made, and grades given for grading the streets and laying pipes where it was necessary.

The records from the four pumping-stations, the lakes, reservoirs, the Mystic sewer, and the returns from pipe foundries, etc., have been carefully kept.

Appended to this report will be found the usual tables of rainfall, consumption, yield of water-sheds, etc.

*Daily Average Consumption of Water, in Gallons, from the Cockshute and Mystic Works.*

MONTH.	COCKSHUTE WORKS.										MYSTIC WORKS.									
	1994.	1995.	1996.	1997.	1998.	1999.	1990.	1994.	1995.	1996.	1997.	1998.	1999.	1990.	1994.	1995.	1996.	1997.	1998.	1999.
January . . . .	32,162,300	26,711,900	28,561,900	32,687,600	40,465,700	30,172,000	33,680,000	8,019,100	7,855,400	8,510,300	10,468,600	11,107,100	7,760,500	8,187,900	6,340,500	10,019,500	9,275,700	9,346,700	11,620,900	9,073,600
February . . . .	24,698,000	31,847,400	28,291,100	31,224,300	43,105,000	36,855,200	33,030,700	6,337,100	8,487,500	7,780,000	8,175,000	9,242,000	7,537,600	8,390,700	6,337,100	8,487,500	7,780,000	8,175,000	9,242,000	7,537,600
March . . . . .	23,711,900	27,697,200	26,886,800	28,124,100	36,463,400	32,180,000	30,844,400	5,242,100	6,042,600	6,636,500	6,933,800	7,276,700	7,185,700	7,481,800	5,242,100	6,042,600	6,636,500	6,933,800	7,276,700	7,185,700
April . . . . .	21,505,700	22,720,450	23,470,400	25,191,500	31,473,900	30,814,500	30,446,800	5,500,000	5,605,700	6,444,000	6,915,300	6,932,300	7,663,600	7,488,400	5,500,000	5,605,700	6,444,000	6,915,300	6,932,300	7,663,600
May . . . . .	23,708,500	22,168,400	24,680,100	27,925,000	30,802,000	32,719,500	31,381,200	6,245,600	6,504,200	6,941,100	7,159,800	7,615,200	8,017,700	8,306,000	6,245,600	6,504,200	6,941,100	7,159,800	7,615,200	8,017,700
June . . . . .	26,184,600	27,214,800	26,574,900	30,069,000	31,026,100	32,377,900	33,022,700	6,212,200	6,513,300	7,437,500	7,250,000	8,267,500	8,315,600	9,465,300	6,212,200	6,513,300	7,437,500	7,250,000	8,267,500	8,315,600
July . . . . .	25,400,000	26,608,200	28,987,500	30,466,700	32,014,400	31,870,300	36,701,100	6,088,400	6,047,600	7,166,900	6,871,000	7,869,100	8,113,200	8,932,200	6,088,400	6,047,600	7,166,900	6,871,000	7,869,100	8,113,200
August . . . . .	25,065,200	24,686,400	24,770,600	30,065,100	32,432,700	31,408,200	36,316,000	6,411,150	5,931,000	7,585,200	6,986,600	7,266,300	7,966,000	8,436,700	6,411,150	5,931,000	7,585,200	6,986,600	7,266,300	7,966,000
September . . . .	26,389,500	26,493,600	25,835,600	31,946,600	31,836,500	31,722,800	36,165,800	5,834,200	5,914,000	6,562,000	6,436,600	7,006,400	7,627,500	7,794,100	5,834,200	5,914,000	6,562,000	6,436,600	7,006,400	7,627,500
October . . . . .	25,022,900	24,945,500	26,713,100	30,562,700	29,110,800	31,702,200	33,429,800	5,119,700	5,710,300	6,546,000	7,361,200	6,960,800	7,316,700	7,601,300	5,119,700	5,710,300	6,546,000	7,361,200	6,960,800	7,316,700
November . . . .	22,954,200	21,942,750	25,036,200	28,062,000	28,560,900	31,532,400	32,955,100	6,330,800	6,356,700	8,043,500	7,882,300	7,918,600	7,473,200	9,448,300	6,330,800	6,356,700	8,043,500	7,882,300	7,918,600	7,473,200
December . . . .	24,224,800	24,724,900	29,706,800	31,511,600	32,686,200	31,829,000	38,334,100	6,200,700	6,737,350	7,399,800	7,629,000	8,258,400	7,830,500	8,301,400	6,200,700	6,737,350	7,399,800	7,629,000	8,258,400	7,830,500
Yearly average .	26,060,500	25,607,200	26,027,900	29,852,100	33,310,700	32,070,000	33,871,700													



diversion for  
whole year



*Diversion of Sudbury-River Water, 1882-90.*

MONTH.	1882.		1883.		1884.		1885.		1886.		1887.		1888.		1889.		1890.	
	To Chestnut-Hill Res'r.	Gallons.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	
January . . .	595,000,000	733,400,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	597,000,000	
February . . .	975,700,000	597,800,000	1,094,300,000	265,400,000	265,400,000	500,400,000	380,800,000	472,000,000	472,000,000	906,700,000	906,700,000	564,600,000	564,600,000	475,000,000	475,000,000	475,000,000	475,000,000	
March . . . .	1,002,300,000	17,200,000	624,700,000	312,500,000	312,500,000	495,900,000	467,400,000	456,700,000	456,700,000	691,400,000	691,400,000	584,500,000	584,500,000	498,600,000	498,600,000	498,600,000	498,600,000	
April . . . . .	781,200,000	967,900,000	535,700,000	228,800,000	228,800,000	350,400,000	307,000,000	385,400,000	385,400,000	468,800,000	468,800,000	490,500,000	490,500,000	417,000,000	417,000,000	417,000,000	417,000,000	
May . . . . .	502,300,000	260,000,000	613,800,000	268,400,000	268,400,000	308,500,000	344,700,000	444,200,000	444,200,000	566,300,000	566,300,000	615,700,000	615,700,000	536,300,000	536,300,000	536,300,000	536,300,000	
June . . . . .	491,800,000	631,600,000	631,600,000	414,500,000	414,500,000	768,000,000	427,100,000	463,600,000	463,600,000	528,900,000	528,900,000	567,600,000	567,600,000	513,100,000	513,100,000	513,100,000	513,100,000	
July . . . . .	646,900,000	754,300,000	754,300,000	430,100,000	430,100,000	434,600,000	534,500,000	387,500,000	387,500,000	626,600,000	626,600,000	534,000,000	534,000,000	664,100,000	664,100,000	664,100,000	664,100,000	
August . . . .	655,800,000	640,900,000	640,900,000	406,100,000	406,100,000	401,100,000	463,100,000	352,800,000	352,800,000	626,600,000	626,600,000	443,700,000	443,700,000	625,500,000	625,500,000	625,500,000	625,500,000	
September . .	308,900,000	467,100,000	467,100,000	442,200,000	442,200,000	386,100,000	414,700,000	577,300,000	577,300,000	581,600,000	581,600,000	475,500,000	475,500,000	606,400,000	606,400,000	606,400,000	606,400,000	
October . . . .	570,300,000	483,300,000	483,300,000	432,900,000	432,900,000	368,300,000	474,100,000	672,300,000	672,300,000	435,900,000	435,900,000	414,100,000	414,100,000	539,900,000	539,900,000	539,900,000	539,900,000	
November . .	572,300,000	580,800,000	580,800,000	363,900,000	363,900,000	297,600,000	381,800,000	607,100,000	607,100,000	410,900,000	410,900,000	454,600,000	454,600,000	526,000,000	526,000,000	526,000,000	526,000,000	
December . .	632,200,000	536,800,000	536,800,000	432,500,000	432,500,000	379,900,000	570,200,000	703,000,000	703,000,000	605,200,000	605,200,000	501,200,000	501,200,000	675,500,000	675,500,000	675,500,000	675,500,000	
Totals . . . .	7,735,200,000	1,245,100,000	7,209,900,000	4,094,300,000	4,094,300,000	5,224,700,000	5,297,600,000	6,124,100,000	6,124,100,000	7,224,700,000	7,224,700,000	6,363,900,000	6,363,900,000	6,596,000,000	6,596,000,000	6,596,000,000	6,596,000,000	
Total diversion from Sudbury river	7,735,200,000	8,435,000,000		6,110,600,000		5,224,700,000	5,297,600,000	6,124,100,000	6,124,100,000	7,224,700,000	7,224,700,000							
Average daily diversion for whole year	21,192,300	23,164,400		16,695,600		14,314,200	14,431,800	16,778,400	16,778,400	19,739,600	19,739,600	17,435,300	17,435,300	18,071,200	18,071,200	18,071,200	18,071,200	



*Statement showing Amount of Water diverted from Sudbury River to Lake Cochituate and Chestnut-Hill Reservoir; Amount wasted; Amount of flow in River; Percentage of Rainfall collected, etc.. 1875 to 1890.*

(Water-shed from 1875 to 1878, inclusive, = 77,764 sq. miles; in 1879 and 1880 = 78,238 sq. miles; and from 1881 to 1890, inclusive, = 75.2 sq. miles.)

YEAR.	Amount of Water diverted to Lake Cochituate and Chestnut Hill Reservoir.	Amount of Water used by Framingham Water Co.	Amount of Water wasted from River.	STORAGE.		Total amount of flow in River.	Daily average amount of flow in River.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1875 . . . .	2,555,800,000	. . . . .	24,971,600,000	66,300,000	. . . . .	27,563,700,000	75,569,200	45.490	20.418	44.88
1876 . . . .	2,528,300,000	. . . . .	29,942,300,000	. . . . .	180,700,000	32,309,000,000	88,278,400	49.583	23.908	48.24
1877 . . . .	1,894,350,000	. . . . .	32,428,300,000	112,100,000	. . . . .	34,444,750,000	94,369,200	44.018	25.487	57.90
1878 . . . .	3,422,100,000	. . . . .	37,125,200,000	654,700,000	. . . . .	41,202,000,000	112,882,200	57.931	30.487	52.63
1879 . . . .	3,749,200,000	. . . . .	20,817,500,000	962,200,000	. . . . .	25,528,000,000	69,942,200	41.419	18.775	45.33
1880 . . . .	6,230,200,000	. . . . .	11,290,000,000	. . . . .	953,600,000	16,561,600,000	42,250,300	38.177	12.182	31.91
1881 . . . .	8,845,300,000	. . . . .	17,279,000,000	751,700,000	. . . . .	26,876,000,000	73,633,900	44.169	20.565	46.56
1882 . . . .	7,735,200,000	. . . . .	16,273,900,000	. . . . .	352,600,000	23,656,500,000	64,812,300	39.394	18.102	45.95
1883 . . . .	8,455,000,000	. . . . .	7,251,900,000	. . . . .	1,086,400,000	14,620,500,000	40,056,200	32.780	11.188	34.13
1884 . . . .	6,110,600,000	. . . . .	23,223,900,000	1,744,600,000	. . . . .	31,084,100,000	84,929,200	47.135	23.784	50.46
1885 . . . .	5,224,700,000	61,800,000	19,878,800,000	. . . . .	446,900,000	24,718,400,000	67,721,600	43.545	18.918	43.44
1886 . . . .	5,296,600,000	76,600,000	23,023,000,000	1,464,500,000	. . . . .	29,831,700,000	81,730,700	46.065	22.825	49.56
1887 . . . .	6,124,100,000	87,500,000	25,334,500,000	117,400,000	. . . . .	31,663,500,000	86,749,300	42.705	24.227	56.73
1888 . . . .	7,224,700,000	61,500,000	39,040,500,000	390,600,000	. . . . .	46,717,300,000	127,642,900	57.465	35.749	62.21
1889 . . . .	6,363,000,000	59,500,000	31,550,400,000	. . . . .	2,800,000	37,871,000,000	104,030,100	49.63	29.056	58.17
1890 . . . .	6,596,000,000	74,500,000	28,667,100,000	. . . . .	57,400,000	35,280,200,000	96,658,100	53.00	26.998	50.94
Averages .	6,620,410,000	70,233,300	24,257,056,300	. . . . .	. . . . .	30,003,753,100	81,965,400	45.80	22.607	48.69

*Statement showing Amount of Water drawn from Mystic Lake; Amount wasted; Amount of Rainfall collected in Lake; Percentage of Rainfall collected, etc., 1876 to 1890; Water-shed of Lake, 17,200 Acres.*

YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	STORAGE.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall col- lected in Lake.	Rainfall.  Inches.	Rainfall collected.  Inches.	Percentage of Rainfall collected.
			Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1876 . . . . .	3,230,101,300	6,369,774,700	.....	32,583,000	9,567,293,000	26,140,100	47.00	20.49	43.6
1877 . . . . .	3,069,554,800	7,250,223,500	.....	16,291,400	10,303,496,900	28,228,700	43.065	22.06	51.2
1878 . . . . .	3,367,400,400	8,718,547,600	.....	26,000,000	12,060,038,000	33,041,200	54.065	25.82	47.8
1879 . . . . .	3,490,848,200	4,625,691,800	.....	203,000,000	7,913,540,000	21,680,900	33.30	16.94	48.0
1880 . . . . .	3,692,195,700	2,158,761,200	.....	113,500,000	5,703,756,900	15,584,000	34.42	12.21	35.5
1881 . . . . .	2,815,579,900	5,534,300,000	371,200,000	.....	8,721,079,900	23,863,400	41.91	18.67	44.5
1882 . . . . .	2,570,896,700	4,444,668,000	15,000,000	.....	7,030,564,700	19,261,800	39.165	15.05	38.4
1883 . . . . .	2,664,514,200	2,034,702,600	.....	347,579,000	4,351,637,800	11,922,300	31.22	9.33	29.84
1884 . . . . .	2,469,761,000	6,574,003,800	380,600,000	.....	9,424,364,800	25,749,600	44.39	20.18	45.46
1885 . . . . .	2,639,278,800	5,588,860,500	.....	33,200,000	8,194,639,300	22,451,900	44.50	17.55	39.43
1886 . . . . .	2,862,947,500	7,745,258,900	.....	28,400,000	10,577,806,400	28,980,300	45.56	22.65	49.71
1887 . . . . .	2,954,257,500	7,414,213,000	.....	11,000,000	10,357,470,500	28,376,600	46.42	22.17	47.77
1888 . . . . .	3,205,121,100	11,354,593,100	.....	6,000,000	14,533,714,200	39,709,600	56.745	31.12	54.84
1889 . . . . .	3,007,539,800	8,579,787,500	12,000,000	.....	11,899,327,300	32,600,900	50.395	25.48	50.56
1890 . . . . .	3,212,284,500	8,953,727,900	.....	3,000,000	12,163,012,400	33,323,300	49.37	26.04	52.75
Average . . . . .	3,016,824,800	6,508,340,900	.....	.....	9,620,135,500	26,063,000	44.237	20.38	45.29

*Statement showing Amount of Water drawn from Lake Cochituate; Amount wasted; Amount of Rainfall collected in Lake; Amount received into Lake from Sudbury River; Percentage of Rainfall collected, etc., 1852 to 1890; Water-shed of Lake, 12,077 Acres.*

YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Amount received into Lake from Sudbury River.	STORAGE.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1852 <sup>1</sup> .	2,974,042,800	4,020,566,900			261,360,000	6,733,249,700	18,394,900	47.93	20.61	43.
1853	3,117,939,500	3,166,417,500		239,580,000		6,523,937,000	17,873,800	55.73	19.51	55.
1854	3,614,220,000	4,187,733,000			217,800,000	7,884,163,000	20,778,500	43.15	22.87	53.
1855	3,776,399,500	No account kept			326,700,000			34.96		
1856	4,409,787,600	"		598,950,000				40.80		
1857	4,644,990,000	10,625,900,000		32,670,000		15,303,560,000	41,927,600	63.10	46.69	74.
1858	4,689,155,000	1,934,500,000			141,670,000	6,482,085,000	17,759,000	48.66	19.46	40.
1859 <sup>2</sup> .	4,808,875,000	7,569,000,000		283,140,000		12,661,015,000	34,687,700	49.02	38.24	78.
1860	6,309,108,000	None.		174,240,000		6,483,348,000	17,714,100	55.44	19.40	33.
1861	6,639,965,900	3,377,559,000			1,459,290,000	8,557,394,900	23,444,900	45.44	26.45	54.
1862	6,069,000,000	33,200,000		1,806,800,000		7,390,900,000	20,271,200	49.69	22.36	45.
1863	6,927,082,500	2,165,696,500		762,300,000		8,555,049,000	24,290,400	69.30	26.88	39.
1864	6,104,306,700	1,368,746,000			1,848,577,000	6,925,475,700	15,370,200	42.00	16.35	43.
1865	4,621,630,000	1,698,120,700		743,242,500		7,062,993,200	19,323,300	49.46	20.50	41.
1866	4,463,585,000	None.		743,242,500		6,206,827,500	14,295,300	62.32	16.01	26.
1867	4,931,223,000	2,482,041,000			698,811,000	6,734,455,000	18,450,000	56.25	21.80	39.
1868	6,406,515,000	2,507,694,000		316,271,000		8,220,170,000	22,567,200	43.71	21.98	50.

1869	5,503,751,000	1,635,570,000	.....	480,862,000	.....	7,620,203,000	20,877,300	64.34	21.99	34.
1870	5,477,810,000	4,818,971,000	.....	.....	1,738,085,000	8,560,896,000	22,453,900	55.89	20.08	47.
1871	5,223,500,000	None.	.....	.....	250,833,000	4,972,567,000	13,623,500	45.39	15.16	33.
1872	5,776,151,200	None.	.....	.....	.....	5,642,480,300	15,416,800	48.47	17.22	35.
1873	6,511,820,900	2,917,977,000	.....	.....	.....	8,914,671,900	24,423,800	45.43	27.13	60.
1874	6,625,972,900	1,145,851,700	.....	.....	.....	6,402,109,600	17,540,000	35.93	19.52	54.
1875	7,092,865,500	None.	.....	.....	.....	5,760,040,500	15,780,900	45.49	17.57	39.
1876	7,277,175,200	1,619,243,800	.....	.....	.....	6,411,557,000	17,517,900	48.49	19.54	40.
1877	7,626,889,200	1,484,978,600	.....	.....	.....	7,596,244,800	20,811,600	43.80	22.17	53.
1878	7,743,904,700	3,241,875,000	.....	.....	.....	8,637,268,700	22,663,700	53.58	26.34	49.
1879	6,051,838,900	1,523,361,400	.....	.....	.....	5,841,203,000	16,003,300	38.01	17.81	47.
1880	4,284,147,100	65,577,700	.....	.....	.....	3,376,719,800	9,226,100	35.83	10.30	29.
1881	2,846,459,700	2,231,016,700	.....	.....	.....	5,357,965,800	14,679,400	41.09	16.34	40.
1882	3,935,490,600	1,358,543,700	.....	.....	.....	4,936,696,600	13,525,200	40.29	15.05	37.
1883	4,731,227,700	162,361,800	.....	.....	.....	3,314,086,500	9,079,700	31.20	10.11	32.
1884	4,533,156,450	1,842,837,100	.....	.....	.....	6,300,130,250	17,213,450	45.57	19.21	42.
1885	4,091,874,900	1,006,622,800	.....	.....	.....	5,106,892,500	13,961,500	43.66	15.67	36.
1886	4,452,536,100	3,116,283,200	.....	.....	.....	7,188,157,300	19,663,800	46.97	21.92	47.
1887	4,802,120,700	3,658,652,900	.....	.....	.....	7,697,568,600	21,089,200	41.58	23.47	56.
1888	4,968,503,100	4,229,200,000	.....	.....	.....	10,157,012,100	27,751,400	56.93	30.97	54.
1889	5,570,423,600	3,373,929,000	.....	.....	.....	9,165,719,400	25,111,600	50.23	27.96	56.
1890	5,722,170,800	2,380,441,200	.....	.....	.....	8,038,445,700	22,023,100	51.23	24.51	48.
Averages	5,213,930,100	2,352,444,800	.....	.....	.....	7,200,163,600	19,718,600	48.02	21.89	45.

1 Observation of rainfall at Lake Cochituate commenced 1882, and these observations are assumed as correct for the whole district.  
 2 Lake raised two feet.

Table showing the Average Monthly and Yearly Heights above Tide-march Level of the Water in the Lakes and Reservoirs of the Boston Water Works.

MONTHS.	Reservoir No. 1. Flash boards. 159.29.		Reservoir No. 2. Flash boards. 167.12.		Reservoir No. 3. Stone crest. 173.24.		Reservoir No. 4. Flash boards. 213.21.		Farm Pond. High water. 149.25.		Lake Cochituate. High water. 134.36.		Chestnut-Hill Reservoir. High water. 124.00.		Brookline Reservoir. High water. 124.00.		Parker-Hill Reservoir. High water. 219.00.		Myette Lake. High water. 7.00.		Myette Reservoir. High water. 147.00.		Fisher-Hill Reservoir. High water. 241.00.	
	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.	1889.	1890.
January .	158.24	157.95	166.35	166.12	175.62	175.55	214.69	214.53	149.43	149.64	132.31	132.49	123.66	123.45	123.46	123.02	—	—	—	—	—	—	—	—
February .	157.92	157.99	166.12	166.15	175.43	175.57	214.54	214.54	149.72	149.27	132.51	132.38	123.61	123.42	123.37	123.24	—	—	—	—	—	—	—	—
March . .	157.94	158.39	166.13	164.63	175.52	173.92	214.51	213.53	149.37	149.54	132.44	132.30	123.84	123.43	123.64	123.27	—	—	—	—	—	—	—	—
April . . .	157.97	158.09	166.55	166.18	175.58	175.56	214.52	214.59	149.35	149.29	133.19	133.03	123.85	123.47	123.67	123.31	—	—	—	—	—	—	—	—
May . . .	158.24	157.96	166.52	166.57	175.51	175.56	214.71	214.54	149.37	149.60	134.09	133.82	123.82	123.79	123.40	123.45	—	—	—	—	—	—	—	—
June . . .	158.88	158.80	166.01	167.18	175.47	175.45	214.76	214.71	149.45	149.59	133.71	133.56	123.75	123.79	123.56	123.61	—	—	—	—	—	—	—	—
July . . .	159.39	159.09	163.52	162.37	175.43	175.17	215.01	213.90	149.36	149.15	132.85	131.99	123.91	123.81	123.72	123.58	—	—	—	—	—	—	—	—
August . .	158.65	158.67	167.27	160.86	175.60	174.21	215.01	208.51	149.55	148.85	132.73	130.34	123.63	123.82	123.44	123.59	—	—	—	—	—	—	—	—
September,	157.81	157.63	167.04	164.02	175.34	175.14	215.09	202.33	149.41	149.07	130.75	129.55	123.56	123.77	123.35	123.54	—	—	—	—	—	—	—	—
October . .	158.00	157.99	164.50	165.85	175.41	175.62	214.77	205.15	149.50	149.54	131.23	130.38	123.54	123.86	123.35	123.53	—	—	—	—	—	—	—	—
November .	158.01	157.92	162.70	166.13	175.54	175.52	214.57	212.53	149.36	149.19	131.77	132.47	123.50	123.88	123.32	123.08	—	—	—	—	—	—	—	—
December .	158.17	157.84	166.27	166.09	175.70	175.47	214.66	214.13	149.46	149.26	132.99	132.64	123.58	123.53	123.37	123.03	—	—	—	—	—	—	—	—
Yearly averages {	158.27	158.19	165.75	165.18	175.51	175.23	214.74	211.92	149.44	149.33	132.55	132.08	123.60	123.67	123.47	123.40	—	—	—	—	—	—	—	—
																		218.09	5.98	146.69	146.67	239.87	239.55	





## Statement of Operations at the Chestnut-Hill Pumping-station for 1890.

1890.	Engine No. 1.		Engine No. 2.		Total amount pumped.	Daily average amount pumped.	Total amount of coal consumed.	Total ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per lb. of coal. No correction for heating and lighting.	Quantity pumped per lb. of coal. Corrected for heating and lighting.	Average lift in feet.	Duty in ft. lbs. per 100 lbs. of coal.			Water evaporated in boiler per lb. of coal.	
	Hours.	Min.	Hours.	Min.	Gallons.	Gallons.	Lbs.	Lbs.	Per cent.	Gallons.	Gallons.	Feet.	Without correction for heating and lighting.	Corrected for heating buildings.	Corrected for heating and lighting.	Actual.	From and at 212°.
Month.													Fl.-Lbs.	Fl.-Lbs.	Fl.-Lbs.	Lbs.	Lbs.
January . .	363 00				128,481,350	179,978,025	5,805,700	19,850	9.5	858.8	938.5	123.58	88,515,900	94,003,900	96,750,000	10.16	11.97
February . .	188 00				63,503,175	159,199,700	5,685,700	18,631	9.9	841.7	948.4	123.53	86,714,700	92,177,700	97,708,400	10.18	11.98
March . .	526 00				181,278,975	181,278,975	5,847,700	20,687	9.8	862.4	960.8	123.21	88,616,000	93,755,700	98,724,800	Meters { disabled.	
April . .																	
May . .																	
June . .																	
July . .																	
August . .																	
September . .																	
October . .																	
November . .																	
December . .																	
Totals and averages . .	3466 05				1,208,902,725	2,369,631,750	6,492,100	219,398	8.2	885.1	954.8	123.16	90,912,300	93,657,900	98,069,200	10.12	11.77



Statement of Operations at the Mystic Pumping-Station for 1890.

1890.	ENGINE NO. 1.				ENGINE NO. 2.				ENGINE NO. 3.				Total amount pumped.	Gallons.	Daily average amount pumped.	Daily average amount of coal consumed.	Lbs.	Daily average amount of ashes and clinkers.	Per cent.	Gal.	Feet.	Average lift in feet.	Duty in foot-pounds per 100 coal.
	Total pumping time.		Gallons.	Amount pumped.	Total pumping time.		Gallons.	Amount pumped.	Total pumping time.		Gallons.	Amount pumped.											
	Hrs.	Min.			Hrs.	Min.			Hrs.	Min.													
Month.	Hrs.	Min.	Gallons.	Amount pumped.	Hrs.	Min.	Gallons.	Amount pumped.	Hrs.	Min.	Gallons.	Amount pumped.	Lbs.	Lbs.	Per cent.	Gal.	Feet.	Feet.	Fi. lbs.				
January					130	15	24,175,100		735	45	230,374,400		8,311,300	17,548	1,505	9.1	467.9	146.61	57,214,100				
February					101	00	19,252,500		672	00	212,761,800		8,286,200	17,768	1,911	10.2	466.4	146.55	56,999,800				
March					57	00	10,736,100		743	15	238,848,000		8,051,100	16,855	1,585	9.4	477.7	146.43	58,334,700				
April									720	00	224,563,200		7,485,400	15,900	1,362	8.6	470.8	146.41	57,485,300				
May					1	00	181,200		743	00	231,116,800		7,461,200	15,806	1,426	9.0	472.0	146.59	57,709,600				
June					100	30	19,418,800		706	45	230,758,400		8,339,200	17,600	1,618	9.2	473.8	146.88	58,042,000				
July					302	15	54,269,400		742	30	241,536,000		9,542,100	20,177	1,940	9.6	472.9	147.82	58,301,300				
August					238	45	43,412,500		697	30	222,566,400		8,945,800	19,000	1,994	10.5	470.8	148.28	58,225,500				
September					261	45	46,432,500		486	15	156,723,200		8,408,200	19,100	2,004	10.5	440.2	148.29	54,443,700				
October					10	15	1,902,600		734	00	239,795,200		7,796,700	16,419	1,730	10.5	474.8	147.54	58,429,300				
November					8	45	1,706,300		714	00	236,739,200		7,614,800	16,467	1,718	10.4	462.4	146.57	56,528,400				
December					82	15	16,262,700		660	45	236,022,400		9,432,800	21,177	2,070	9.8	445.4	147.34	54,732,700				
Totals and Averages	430	00	77,644,200		1,426	15	270,667,500		8,355	45	2,681,804,800		8,301,700	17,825	1,738	9.8	465.7	147.11	57,141,800				

*Rainfall in Inches and Hundredths on the Sudbury River Water-shed for the Year 1890.*

1890.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. ....	...	...	0.18	...	0.17	...	...	...	...	...	...	...
2. ....	...	0.13	...	...	...	...	...	...	...	...	...	...
3. ....	...	...	1.075	...	...	...	0.115	...	...	...	...	1.055
4. ....	...	0.155	...	0.17	...	0.275	0.025	...	...	2.50	...	...
5. ....	...	...	0.05	...	0.88	0.29	0.135	...	0.105	...	...	...
6. ....	0.19	...	0.885	...	0.635	0.22	...	0.01	2.125	...	...	0.285
7. ....	...	...	...	0.415	...	...	0.035	...	...	...	...	...
8. ....	...	0.88	...	...	0.205	...	...	...	...	0.76	...	...
9. ....	...	...	...	0.91	...	...	...	0.295	...	...	...	...
10. ....	...	0.07	...	...	0.365	...	...	0.075	0.185	0.055	...	...
11. ....	0.63	...	0.10	...	...	...	...	...	...	...	...	...
12. ....	...	...	...	...	...	...	...	...	...	...	0.215	...
13. ....	0.04	...	...	...	0.09	1.035	...	...	1.52	...	...	...
14. ....	...	0.245	...	...	0.46	...	...	0.065	...	0.575	...	...
15. ....	...	...	1.36	...	0.43	...	...	...	...	...	0.21	...
16. ....	0.74	...	...	...	0.05	...	...	...	0.55	...	...	...
17. ....	...	...	...	...	...	...	...	0.655	...	1.595	0.775	2.15
18. ....	...	0.235	...	...	...	...	...	...	1.225	...	...	...
19. ....	...	...	0.56	...	...	...	0.42	...	...	...	...	...
20. ....	0.095	0.66	...	...	0.65	...	0.02	0.735	...	2.18	...	...
21. ....	...	...	0.055	...	...	...	...	0.075	...	...	...	...
22. ....	...	...	...	...	...	...	...	...	...	...	...	...
23. ....	0.08	...	2.135	...	...	...	...	0.675	...	...	...	0.01
24. ....	...	...	...	...	...	...	...	...	...	2.45	...	...
25. ....	...	0.705	0.365	0.215	...	0.06	0.555	...	...	...	...	...
26. ....	...	...	...	...	...	...	0.84	...	0.29	...	...	1.76
27. ....	0.515	...	...	0.935	1.10	0.16	...	1.17	...	...	...	...
28. ....	...	0.425	...	...	0.175	...	...	...	...	...	...	...
29. ....	...	...	0.82	...	...	...	0.085	...	...	0.395	...	...
30. ....	...	...	...	...	...	...	...	0.11	...	...	...	0.05
31. ....	0.24	...	0.15	...	...	...	0.23	...	...	...	...	...
Totals . .	2.53	3.505	7.735	2.645	5.21	2.03	2.46	3.865	6.00	10.51	1.20	5.31

Total rainfall during the year, 53.00 inches.  
Being an average of two gauges, located at Framingham and Ashland.

*Rainfall in Inches and Hundredths at Lake Cochituate, for the Year 1890.*

1890.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1 . . . . .					0.17							
2 . . . . .		0.11										
3 . . . . .			1.20				0.08					1.16
4 . . . . .		0.15		0.16			0.07			2.39		
5 . . . . .					1.24			0.09				
6 . . . . .	0.18		0.81		0.58	0.77		0.01	1.64			0.27
7 . . . . .				0.42			0.04					
8 . . . . .		0.77			0.22					0.70		
9 . . . . .				0.87				0.39	0.19			
10 . . . . .		0.06			0.31			0.02		0.11		
11 . . . . .	0.49											
12 . . . . .			0.11					1.00			0.23	
13 . . . . .	0.04				0.06	0.98						
14 . . . . .		0.22						0.12		0.50		
15 . . . . .			1.30		0.89						0.22	
16 . . . . .	0.74				0.02							
17 . . . . .								0.57		1.53	0.79	1.99
18 . . . . .		0.24							3.24			0.01
19 . . . . .			0.59				0.18					
20 . . . . .	0.06	0.62			0.63			0.65		2.23		
21 . . . . .			0.05					0.01				
22 . . . . .												
23 . . . . .	0.07		2.08					0.42				0.02
24 . . . . .						0.03				2.23		
25 . . . . .		0.70	0.29	0.16								
26 . . . . .							1.22		0.31			1.81
27 . . . . .	0.52			0.90	1.07			1.03				
28 . . . . .		0.35			0.12							
29 . . . . .			0.75				0.08			0.42		
30 . . . . .								0.12				
31 . . . . .	0.24		0.17				0.64					
Totals . .	2.34	3.21	7.35	2.51	5.31	1.78	2.31	3.34	6.47	10.11	1.24	5.26

Total Rainfall during the year, 51.23 inches.

*Rainfall in Inches and Hundredths on the Mystic Lake Water-shed for the Year 1890.*

1890.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. ....	...	...	0.20	...	0.20	...	...	0 025	...	...	...	...
2. ....	...	0.155	...	...	...	...	...	...	...	...	0.005	...
3. ....	...	...	0.80	...	...	...	0.02	...	...	...	...	1.135
4. ....	...	0.12	...	0.16	...	0.54	0.01	...	...	1.21	...	...
5. ....	0.35	...	...	...	1.18	0.43	...	...	0.01	...	...	...
6. ....	0.02	...	0.78	...	0.92	0.28	...	0.03	0.805	...	...	0.285
7. ....	...	...	...	0.44	...	...	0.01	...	...	0.17	...	...
8. ....	...	0.71	...	...	0.395	...	...	...	...	0.62	...	...
9. ....	...	...	...	0.81	...	...	...	0.37	...	...	...	...
10. ....	0.11	0.05	...	...	0.37	...	...	0.21	0.225	0.075	0.02	...
11. ....	0.445	...	0.10	...	...	0.62	...	0.005	0.30	...	...	...
12. ....	...	...	...	...	...	0.525	...	...	0.53	...	0.23	...
13. ....	0.035	...	0.01	...	...	0.89	...	...	0.12	...	...	...
14. ....	...	0.255	...	0.006	0.375	...	...	...	0.075	0.315	...	...
15. ....	0.405	...	1.325	...	0.44	...	...	...	0.585	...	0.235	...
16. ....	0.215	...	...	...	0.11	...	...	...	0.53	...	...	...
17. ....	...	...	...	...	...	...	0.01	0.435	0.19	1.87	0.895	...
18. ....	...	0.325	...	...	...	...	...	...	...	...	...	1.88
19. ....	...	...	0.415	...	...	...	0.30	...	...	...	...	...
20. ....	0.12	0.68	...	...	0.715	...	0.025	0.86	...	2.405	...	...
21. ....	...	...	0.05	...	...	...	...	0.04	...	...	...	0.005
22. ....	0.01	...	...	...	...	...	...	0.135	...	...	...	...
23. ....	0.11	...	1.78	...	...	...	...	0.195	...	...	...	...
24. ....	...	0.04	...	...	...	...	0.36	0.005	...	1.77	...	...
25. ....	...	0.65	0.28	0.135	...	0.05	0.305	...	...	...	...	...
26. ....	...	...	...	...	...	...	0.93	...	0.33	...	...	1.365
27. ....	0.55	0.04	...	0.855	1.48	0.045	...	0.975	...	...	...	...
28. ....	...	0.355	0.75	...	0.115	...	...	...	...	...	...	...
29. ....	...	...	0.08	...	...	...	0.025	...	...	0.505	...	...
30. ....	0.275	...	...	...	...	...	...	0.355	...	...	...	...
31. ....	0.08	...	0.11	...	...	...	0.27	...	...	...	...	...
Totals . .	2.725	3.38	6.68	2.405	6.30	3.38	2.265	3.64	3.70	8.84	1.385	4.67

Total rainfall during the year, 49.37 inches.

Being an average of two gauges located at Mystic Lake and Winchester.

*Monthly Rainfall in Inches, during 1890, at Various Places in Eastern Massachusetts.*

PLACE.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lake Cochituate . . . . .	2.34	3.21	7.35	2.51	6.31	1.78	2.31	3.34	6.47	10.11	1.24	5.26	51.23
Framlingham . . . . .	2.54	3.60	7.73	2.83	4.94	1.97	2.37	3.72	6.51	10.26	1.25	5.20	52.72
Dam 4, Ashland . . . . .	2.52	3.41	7.74	2.66	5.48	2.09	2.55	4.01	5.49	10.76	1.15	5.42	53.28
Chestnut Hill . . . . .	2.52	3.12	7.64	2.83	5.80	2.60	2.43	3.37	4.89	8.79	1.37	4.76	50.22
Mystic Station, Winchester . . . . .	2.66	3.40	6.47	2.35	6.41	3.42	2.19	3.56	3.50	8.39	1.41	4.26	48.02
Mystic Lake . . . . .	2.79	3.36	6.80	2.46	6.19	3.34	2.34	3.72	3.90	9.29	1.36	5.08	50.72
Mystic Engine-House . . . . .	2.47	3.25	6.49	2.43	5.83	3.32	2.02	3.35	3.85	9.00	1.36	4.27	47.64
Boston Pipe Yard . . . . .	2.54	3.05	6.49	2.785	5.42	2.53	1.76	2.995	6.12	7.92	1.11	3.82	46.53
Cambridge Observatory . . . . .	1.97	2.85	6.53	2.03	5.06	2.80	1.42	3.15	3.70	8.09	1.15	5.15	43.90
Waltham, Boston Manufacturing Co. . . . .	2.30	3.28	7.04	2.51	5.66	2.56	2.13	3.66	4.91	10.48	1.34	5.15	51.02
Lowell, Locks and Canals Co. . . . .	2.766	2.767	6.833	1.987	5.669	3.530	3.447	4.866	4.457	7.705	1.584	4.466	50.077
Lowell-Merrimac Manufacturing Co. . . . .	2.20	4.18	6.65	2.36	5.20	3.70	3.36	4.95	4.28	6.68	1.46	3.96	48.98
Average of twelve places . . . . .	2.403	3.290	6.988	2.470	5.581	2.803	2.360	3.724	4.840	8.956	1.315	4.733	49.528

*Rainfall Received and Collected, 1890.*

MONTH.	SUDBURY.			COCHITUATE.			MYSTIC.		
	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.
	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.
January . .	2.53	2.237	88.43	2.34	1.92	82.03	2.725	2.07	75.00
February . .	3.506	2.464	70.29	3.21	2.04	63.43	3.38	2.23	65.98
March . . .	7.735	6.498	84.01	7.35	5.87	79.86	6.68	5.37	80.41
April . . .	2.645	3.236	122.35	2.51	2.23	88.86	2.405	2.93	121.80
May . . . .	5.21	2.437	46.78	5.31	1.85	34.90	6.30	3.00	47.59
June . . .	2.03	0.980	48.27	1.78	1.41	79.05	3.38	1.02	56.86
July . . . .	2.46	0.192	7.78	2.31	0.33	14.18	2.265	0.43	18.96
August . .	3.865	0.235	6.08	3.34	0.46	13.88	3.64	0.46	12.69
September .	6.00	0.790	13.16	6.47	1.40	21.63	3.70	0.58	15.64
October . .	10.51	4.053	38.56	10.11	3.40	33.67	8.84	2.61	29.51
November .	1.20	2.097	174.72	1.24	1.49	119.95	1.385	1.95	141.16
December .	5.31	1.779	33.49	5.26	2.11	40.19	4.67	2.49	53.48
Totals and averages	53.000	26.998	50.94	51.23	24.51	47.85	49.370	26.04	52.75

*Table showing the Temperature of Air and Water at Various Stations on the Water Works.*

1890.	TEMPERATURE OF AIR.						TEMPERATURE OF WATER.	
	Chestnut-Hill Reservoir.			Framingham.			Brookline Reservoir.	Mystic Engine-house.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Mean.	Mean.
January . . . .	64.0	5.5	32.0	65.0	12.0	32.3	36.0	35.5
February . . . .	63.0	-2.0	31.9	62.0	-1.0	32.6	36.1	35.6
March . . . . .	65.0	-1.0	33.1	64.0	-3.0	32.9	37.6	35.7
April . . . . .	72.0	22.5	45.9	72.0	24.0	47.0	46.8	43.7
May . . . . .	81.5	34.5	57.2	81.0	34.0	58.2	58.8	59.9
June . . . . .	88.5	42.0	64.7	88.0	42.0	65.4	65.5	64.4
July . . . . .	94.5	47.0	70.9	95.0	47.0	71.2	72.3	73.7
August . . . . .	89.5	47.5	68.9	88.0	47.0	69.3	73.2	74.6
September . . . .	84.5	35.5	63.2	82.0	30.0	62.2	68.1	68.2
October . . . . .	78.0	31.0	49.8	74.0	28.0	48.6	50.6	57.5
November . . . .	65.0	14.0	40.4	65.0	13.0	37.9	44.7	45.5
December . . . .	54.5	1.0	25.4	50.0	-1.0	24.1	37.4	35.9

## C. — IMPROVED SEWERAGE.

The work of constructing the extension of the improved sewerage system has been prosecuted during the past year as rapidly as the funds available would permit.

The condition of the appropriation on Jan. 1, 1891, was as follows: —

Total appropriations . . . . .	\$5,913,089 93
Total expended . . . . .	5,672,836 76
	<hr/>
Unexpended balance Jan. 1, 1891 . . . . .	\$240,253 17

The amount expended during the past year was \$253,585.02.

The following statement shows the amount of work done during the past year, also the work now in progress and work proposed to be done.

## CITY PROPER, SECTION 7, WEST SIDE.

This section completes the west side intercepting sewer, and extends in Commercial street, from Prince street to Charter street, a distance of 528 linear feet.

The sewer is of Akron pipe, 15-inch diameter, imbedded in concrete.

Its inclination is 1 foot in 400, and at its upper end its elevation is 60 feet above low water.

This sewer intercepts the sewage which was formerly discharged into the docks at the foot of Hull and Charter streets.

Proposals for the construction of this sewer were opened on May 7, 1890, but as the lowest proposal greatly exceeded the engineer's estimate, it was decided to do the work by day labor. The total cost of this sewer, which was completed in June, 1890, was \$4,292, which was \$761 less than the lowest proposal received from contractors.

## SECTIONS 5 AND 6, EAST SIDE.

These sections extend in Atlantic avenue and Commercial street, from Central wharf to Hanover street, a distance of 3,165 linear feet. Work was begun in July, 1890, and is in progress at the present time. Owing to the character of the made land through which the sewer would be located,



and the possibility of encountering old sea-walls, wharves, building foundations, piles, etc., whose location could not be accurately shown, it was impracticable to let these sewers by contract, and the work has been conducted by day labor, under a superintendent appointed by the city.

The sewers are of brick, egg-shaped, 42 in. by 28 in. in diameter, with concrete foundations and side walls. The inclination of the sewer is 1 foot in 1,500, and its elevation at the upper end is 4.3 feet above low water. Owing to the proximity of the tide-water and the numerous old sea-walls encountered in the trench, the work can be conducted at low tide only, as tide-water finds free access to the trench. For a length of 200 feet a solid stratum of old log cob-work, 8 feet in thickness, was encountered. The numerous obstructions, such as sea-walls, logs, piles, etc., found in the trench, combined with the short space of time that it is possible to carry on the work, makes these sections difficult to build and expensive.

The sewers will be completed in September, 1891, and will intercept the sewage now being discharged into the docks at the foot of Clark, Battery, and Hanover streets.

#### SECTION 1, BRIGHTON.

The contract for building this sewer, which extends in Huntington avenue from Gainsboro' street to Parker street, a distance of 1,833 linear feet, was awarded to the Metropolitan Construction Co., of Boston, and work was commenced on June 24, 1890, and finished in December, 1890.

Owing to the quicksand bottom, and the proximity of several heavy buildings whose foundations were thought to be insecure, considerable trouble was anticipated in the construction of this sewer. By adopting the precaution of driving tongued and grooved sheet piling through the quicksand into the underlying clay, the difficulties were surmounted, and no damage to either buildings or sewer has resulted. The sewer is of brick, circular, 6 feet 6 inches in diameter and 8 inches in thickness, with a foundation of timber and concrete and rubble masonry side-walls. Its inclination is 1 foot in 2,500, and its elevation at the upper end is 4.2 feet below low water. The sewer intercepts the sewage which formerly emptied into the Charles river through the Stony-brook channel. This sewage in time of heavy rain overflowed into the Back-Bay Fens, and the construction of the present sewer will tend to do away with the former nuisance.

The Massachusetts State Drainage Commission is now

extending this sewer to Brookline, Brighton, Watertown, Waltham, and Newton, and in the course of the next four years it is expected that the sewage from these towns will be taken out of the Charles river and emptied at Moon Island.

### SOUTH BOSTON.

Section 8, South Boston intercepting sewer, work on which was in progress at the time of the last annual report, has been completed.

The sewer extends in W. First and E. Second streets, from D street to H street, a distance of 2,365 linear feet. The sewer is of brick, egg-shaped, 48 in. by 36 in. in diameter, with a concrete foundation and rubble masonry side-wall; its inclination is 1 foot in 2,500. The sewer was built by the Metropolitan Construction Co.; it intercepts the sewage which was formerly discharged into the dock at F street, and a nuisance at this point, which was the cause of constant complaint, has been abated. In connection with this section, an overflow has been built at D street, and a regulator chamber has been built at the F-street sewer connection.

Section 9 of the South Boston sewer has also been completed during the past year. This section extends in H street and E. First street as far as L street, a distance of 1,863 linear feet. This sewer is of brick, egg-shaped, 48 inches by 36 inches in diameter for a distance of 688 feet, and 36 inches by 24 inches in diameter for a distance of 1,175 feet, with an inclination of 1 in 2,500 and 1 in 940, respectively. The elevation of the sewer at L street, its upper extremity, is 8.25 feet above low water. The sewer was built by contract by Messrs. Collins & Ham. It intercepts the sewers which formerly discharged into the docks at I and L streets, and relieves the nuisances formerly existing at these points. In connection with this sewer, regulator chambers have been built on the connections with the I and E. First street sewers.

Bids for the construction of Section 7, South Boston intercepting sewer, were opened on May 7, 1890, and the contract awarded to Messrs. Perkins & White, the lowest bidders; the work was completed in October.

The sewer is of Akron pipe, 15 inches in diameter, imbedded in concrete and laid on an inclination of 1 in 600. The sewer extends through the Marine park and Q street, from Sixth street to E. First street, a distance of 2,152 linear feet. This sewer intercepts sewer which formerly discharged at the foot of E. First street. The construction of Sections 7, 8, and 9 completes the extension of the Improved

Sewerage System in South Boston, and all sewage formerly emptying along the water front is now conveyed to Moon Island.

#### DORCHESTER.

Section 3, Dorchester intercepting sewer, work on which was progressing at the time of the last annual report, was finished in September, by A. A. Hall, at a cost of \$28,400. The sewer extends in Commercial and Beach streets, from Clayton to Park street, a distance of 2,093 linear feet; it is of brick, circular, 4 feet 6 inches in diameter; its inclination is 1 in 2,500, and its elevation at the upper end is 1.68 feet above low water.

Bids for the construction of Section 4, Dorchester intercepting sewer, were opened on May 7, and the contract awarded to Messrs. Collins & Ham. The section extends in Park street and through private land to Mill street, a total distance of 2,071 linear feet. The sewer is of brick, circular, 4 feet 6 inches in diameter, laid on an inclination of 1 in 2,500; it was completed in December, 1890. A flushing manhole is built on this sewer at the crossing of Smelt Brook Creek.

Section 5 of the Dorchester intercepting sewer, bids for the construction of which were received on May 7, was completed by Mr. H. P. Nawn in October. The sewer is of brick, circular, 4 feet 6 inches in diameter, laid on an inclination of 1 in 2,500. The sewer extends through private lands from Mill to Commercial street, a distance of 2,120 feet. The sewer at its upper end is 3.4 feet above low water; part of the land through which the sewer passes is at such a low elevation as to require an embankment to be built over the sewer to protect it from frost.

No work has been done on Sections 6, 7, 8, and 9, as the appropriation was decreased by the sum of \$100,000, transferred on June 7, for the purpose of building a part of the outfall sewer between Squantum and Moon Island, and the available balance is not sufficient to construct these sections.

Section 10, which extends through Butler and Adams streets, a distance of 1,600 linear feet, in the vicinity of Dorchester Lower Mills, has recently been put under contract. This section is to be built by tunnelling through the hill, and as the work is necessarily of a slow nature, construction will be commenced in advance of the other sections. This section will be completed in September, 1891.

Section 11, which is the last section of the proposed Dorchester intercepting sewer, extends through private land from Adams street to Central avenue, and will furnish an

outlet for the sewage of the thickly settled territory in the vicinity of River street. No work can be done on this sewer until an appropriation is made for it.

To complete Sections 6, 7, 8, 9, and 11, thus furnishing an intercepting sewer from Dorchester Lower Mills to the end of the present intercepting sewer at Commercial street, and enabling sewage to be taken out of the Neponset river at Dorchester Lower Mills and conveyed to Moon Island, will require the further appropriation of \$150,000.

Considering the fact that the Lower Mills is entirely wanting in sewerage facilities, owing to the lack of this outlet, the advisability of appropriating the above sum is apparent. If the necessary appropriation can be obtained early this season, the entire sewer will be completed by December, 1891, and all the sewage from Dorchester Lower Mills can be emptied at Moon Island.

#### OUTFALL SEWER.

On June 7 the sum of \$100,000 was transferred from the appropriation for Improved Sewerage for the special purpose of building part of the outfall sewer between Squantum and Moon Island. A wooden flume was built in 1884 for the purpose of conveying the sewage between these points, until the earth embankment, in which it was finally proposed to build the permanent masonry sewer, should have consolidated and ceased settling. The embankment having practically ceased settling, and the wooden flume being now badly decayed, the construction of the masonry conduit was deemed advisable.

The construction of the masonry conduit in this embankment was so important a matter that Mr. Jos. P. Davis, the former City Engineer, was engaged as consulting engineer, and he reports as follows:—

NEW YORK, Dec. 29, 1890.

MR. WILLIAM JACKSON, *City Engineer*:—

DEAR SIR,— In reply to your request for my opinion as to the advisability of constructing at the present time a sewer from Squantum to Moon Island, on the embankment built for it some seven years ago, I would say:—

While the records in your office show that the settling of the embankment has not wholly stopped, yet the annual amount is now so small and its rate is so rapidly decreasing that I am of the opinion you need have no apprehension of a further settlement of sufficient magnitude to endanger the sewer.

Considering the dilapidated condition of the wooden flume now in use, the need of greater capacity of flow than is afforded by it to more fully utilize the storage basins, I would advise that a masonry sewer of large capacity be built as soon as practicable.

I have examined your design for the sewer and believe it to be well devised for its purpose and location.

Yours truly,

(Signed)

Jos. P. DAVIS,

*Consulting Engineer.*

The distance between Squantum and Moon Island is 4,020 feet, and the estimated cost of the sewer, which is 11 feet by 12 feet in inside diameter, for the entire distance, is \$185,000.

Bids were opened on July 24 for the construction of 2,100 feet of this sewer, and construction was begun immediately by Mr. H. P. Nawn, the lowest bidder. The sewer is built of brick, of a horseshoe shape, 11 feet high and 12 feet wide. A very heavy concrete base, 4 feet thick, acts as a foundation, and the sewer is further reënforced by the construction of stone-masonry side-walls. Iron rods extend through this concrete foundation and through the arch of the sewer, to strengthen it and permit of slight settlements taking place in the embankment without injury to the sewer. In order to complete the sewer it will be necessary to appropriate the additional sum of \$85,000, required for the construction of the remaining 1,920 feet.

The total length of intercepting sewer which has been built during the year is 14,845 feet.

The balance of the appropriation now on hand will complete all work now under contract, but to complete the Improved Sewerage System, as proposed, including Sections 6, 7, 8, 9, and 11, of the Dorchester intercepting sewer, the sewer from Squantum to Moon Island, the sea-wall at Moon Island, and the pumping-station at the east shaft of the Dorchester-Bay tunnel, will require \$350,000.

## D. — PARKS.

[From the City Engineer's report to the Board of Park Commissioners.]

## THE PARKWAY — BACK-BAY FENS.

*Excavation of Waterway.* — As stated in the last report, this work was at that time completed, excepting the channel from the fen bridge to Brookline avenue. Work was resumed in May, when the additional land needed in this vicinity had been acquired, and has been continued since that time, but at considerable disadvantage, by reason of the difficulty of disposal of the excavated material. The excavation will probably be completed during the present winter in season to allow of the adjoining slopes being prepared for planting.

On August 8 a contract was made with James A. Murphy for excavating at Longwood entrance, near Brookline avenue. This contract was completed October 14, and under it there were excavated 7,706 cubic yards, at 34½ cents per cubic yard.

*Roadways and Walks.* — The main drive from the Westland entrance to Parker street, at the Huntington entrance, has been completed, and the ride and walk between the same and the waterway finished, with the exception of a short length between the gate-chamber and the new outlet of Stony brook. Catch-basins and drains have been constructed on this section.

Considerable quantities of broken stone, paving-blocks, and curbstone are on hand for the extension of this work as soon as the bridge over Stony brook is built.

*Grading of Slopes, Loaming, and Planting.* — The four acres mentioned in the last report as being ready for planting have been planted, and an additional area of about one acre, on the Huntington and Longwood entrances, has been graded and covered with loam.

*Filling.* — On September 16 a contract was made with the Boston & Albany R.R. Co. for grading the Tremont and Longwood entrances. The price to be paid for the filling-in place is 51 cents per cubic yard, bank measurement. Work was begun on October 28, and is now in progress.

*Miscellaneous.* — One hundred settees were purchased during the year, and have been placed along the walks.

Ten geese and six ducks, of different varieties, were placed in the pond in the spring.

A new floor has been laid on the Beacon-entrance bridge, and the iron-work of the bridge thoroughly cleaned and painted. The bridge had not been painted since its construction, in 1882.

The platform covering the gates at the outlet of the pond near Beacon street has been repaired.

A new plan having been adopted for the laying out and grading of the plantations on that part of Commonwealth avenue between West Chester park and Beacon street, the work of regrading was begun late in the fall, and will be completed early in the spring.

The following table gives the principal items of work completed to date : —

		Per cent. of whole.
Channel, excavated . . .	1,196,000 sq. ft.	97
Shore, completed . . .	23,600 lin. ft.	88
Marsh, " . . .	832,500 sq. ft.	99
Driveway, " . . .	52,000 sq. yds.	59
Walks, " . . .	19,400 sq. yds.	37
Ride, " . . .	5,200 sq. yds.	39
Curbstone set . . .	24,511 lin. ft.	71
Gutters paved . . .	11,690 sq. yds.	59
Area covered with loam . . .	906,000 sq. ft.	66
Area planted . . .	809,000 sq. ft.	59
Boundary fence . . .	4,047 lin. ft.	26
Drains laid . . .	5,776 lin. ft.	
Manholes . . .	6	
Catch-basins . . .	72	

Considerable work besides that described in the table has been but partially completed, and cannot as yet be classified.

The usual force has been employed during the year in the care of the plantations, roads, walks, etc.

#### MUDDY RIVER AND STONY BROOK COVERED CHANNELS.

The former of these remains in the same condition as was described in the report for 1888. A section of the Stony-brook conduit, about 650 feet in length, has been for some time distorted in shape, and is under the portion of the fenway which was finished during the past season ; as the construction of the roadway necessitated additional filling, it was thought best to repair and strengthen the conduit. This

was done at small expense. The gate-chamber was also cleaned, and the gates put in order.

### MUDDY RIVER.

In October, contracts were made with the following persons for doing the rough grading on this portion of the parkway, in accordance with plans prepared by the landscape architects : —

*Section A.* — James Killian.      *Section B.* — Owen Nawn.  
*Section C.* — Edward F. Brigham.      *Section D.* — H. P. Nawn.

Owing to the lateness of the season when work was begun but a small amount has been done under these contracts.

### ARNOLD ARBORETUM.

At the beginning of the year work was in progress upon the sub-grading of the road from the main drive to the Walter-street entrance. This work has been completed, and comprises all of the grading of the road-bed and the side slopes, the building of three culverts, and the laying of drains through the slopes where they will be needed as outlets for catch-basins.

The crusher has been removed ; the knoll occupied by it has been restored to its previous condition, and the temporary dam, built to retain water for the use of the crusher-engine, has been removed.

The gravel-pit near Bussey street has been graded, and the slopes left in condition for planting.

On October 7 a contract was made with William T. Davis for grading the driveway around the northerly side of Bussey hill, and across the meadow towards Centre street, opposite Orchard street. Work was begun under this contract on October 11, and is now in progress.

### FRANKLIN PARK.

*Drives, Ride, and Walks.* — That portion of Glen Road which follows the location of the old road and the adjacent walks has been completed to the westerly line of the park.

Glen lane at its easterly end has been finished as far as the crossing of the old road, and has been partially graded for the remaining portion to Blue Hill avenue.

The Circuit drive has been finished from valley gate eastward to its junction with the drive leading to Blue Hill



avenue, opposite Columbia street. The walks near this part of the Circuit drive have also been finished.

The entrance from Columbia street has been completed and foundations laid for a gateway at the entrance to the Country park.

The Circuit drive on the southerly side of the park has been extended to its junction with the drive leading to the summit of Scarboro' hill.

The Scarboro' hill drive and the concourse at the summit of the hill have been completed, the latter requiring a retaining-wall to support it. The walk from the site of the proposed dairy to the top of Scarboro' hill has been finished, including a long flight of stone steps.

Loop road has been entirely sub-graded, the gutters paved, drains and catch-basins constructed, and the roadway ballasted; there only remains the surfacing of the latter with crushed stone when the road will be ready for use. This will require but a short time after spring opens. A retaining-wall to support a portion of this drive, and a flight of stone steps on an approach from the Circuit drive, have been built.

About 1,500 linear feet of ride have been finished.

The fifteen-ton steam road-roller, purchased in the spring, has been of great assistance in the construction of roads and walks.

*Playstead Green.* — The lower portions of this ground have been under-drained by the laying of 6,310 linear feet of agricultural tiles

*Boundary Wall.* — This wall has been extended along Glen lane as far as the crossing of the old Glen road.

*Ellicottdale.* — This ground has been seeded, and is now completed, together with the walks around it, except a small part on the easterly side where the gardener's cottage stands, and where a road was left for the purpose of hauling stone from the quarry.

*Nazingdale.* — The channel of the brook has been excavated as far as the small pond south of Abbottswood; the pond has been deepened and the banks of both the pond and brook have been graded, so that this portion of the park may be considered finished.

*Schoolmaster Hill.* — The masonry-work of the proposed arbor for picnic parties has been nearly finished and two drinking-fountains built. A four-inch water-pipe was laid from the main pipe in Circuit drive for supplying water to the fountains.

*Miscellaneous.* — The flock of sheep has increased during the year from 56 to 115, and the yield of wool was 347 lbs.

The six peafowl, purchased in the spring, have been kept at the Overlook; these have increased in number to eleven.

A flock of pigeons has been placed in the dove-cote in the Playstead shelter.

The temporary skating-pond in Nazingdale was not much used last winter, as there were but few days when the ice was strong enough for skating; during the present winter, however, there have already been about two weeks of skating, and large numbers of young people have enjoyed it.

The following table shows the principal items of work completed to date, but it must not be understood as being a complete statement of the work done, as a large amount of labor has been expended on work which is yet unfinished, and therefore unclassified:—

Driveways completed . . .	67,000 sq. yds., or $4\frac{1}{4}$ miles.
Walks completed . . .	41,000 sq. yds., or $5\frac{3}{4}$ miles.
Ride completed . . .	4,200 sq. yds., or 1,500 lin. ft.
Gutters paved . . .	14,000 sq. yds.
Curbstone set . . .	4,500 lin. ft.
6-in. water-pipe laid . . .	3,000 lin. ft.
4-in. water-pipe laid . . .	1,150 lin. ft.
Hydrants . . .	7
Drinking-fountains . . .	7
Bridge . . .	1
Boundary wall . . .	3,250 lin. ft.
2 ft. 9 in. brick drain . . .	706 "
2 ft. $\times$ 2 ft. 6 in. brick drain, . . .	180 "
2-ft. brick drain . . .	769 "
18-in. pipe drain . . .	2,623 "
15-in. pipe drain . . .	2,805 "
12-in. pipe drain . . .	1,546 "
10-in. pipe drain . . .	1,844 "
8-in. pipe drain . . .	6,737 "
4-in. pipe drain . . .	190 "
4-in. agricultural tile drain . . .	2,100 "
3-in. agricultural tile drain . . .	3,520 "
2-in. agricultural tile drain . . .	26,713 "
1½-in. agricultural tile drain . . .	13,255 "
Total drain . . .	63,078 "
Manholes . . .	39
Catch-basins and inlets . . .	126
Open channel for brook . . .	2,300 lin. ft.
Area of ground graded and planted, or seeded . . .	74 acres.

Loop road has also been graded and ballasted its length, being about 3,200 linear feet.

## MARINE PARK.

*Iron Pier.* — The last span connecting the iron pier with the pier-head has been put in place.

*Pier-head.* — The contract for building the pier-head was completed on September 3. As was anticipated, there has been some settlement, but no damage has been done that cannot be repaired at small expense.

*Filling.* — The contract with Joseph E. White, dated October 5, 1889, was modified on June 28, 1890, so that the amount of filling to be done under the contract should be 250,000 cubic yards. There have been deposited to date 205,000 cubic yards.

On September 10 a contract was made with Perkins & White for 400,000 cubic yards of filling. Under this contract there have been deposited to date 62,000 cubic yards.

*Miscellaneous.* — The railing on the wooden pier, the shelter on the wooden pier, and the Refectory Building have been painted, and the walk from Q street has been relaid.

## WOOD ISLAND PARK.

The work of grading in progress at the beginning of the year was continued through the summer. All of the present upland, except a small portion at the northerly end of the playground, has been graded. The walks are sub-graded, but not surfaced.

The plantations have received a top dressing of stable manure and other fertilizers, and have been ploughed and seeded so that they can be planted in the spring.

All necessary drains have been constructed, there having been laid 5,612 linear feet of drains and 7 catch-basins and inlets built.

## CHARLESBANK.

The boat landings were put in shape for use early in the spring by erecting railings and gates. A flagstaff was placed on the northerly landing. This landing has been occupied during the season by Mr. Partelow for the leasing of pleasure boats; he has had a float attached to the wall, and has kept a large number of boats, including a steam launch.

A building is now being erected at the southerly end of the park, in the lower story of which there will be a tool-room and offices for the foreman and boatman. The upper story is to be used as a dressing-room and lavatory for women; through it entrance can be had to the women's gymnasium.

The women's gymnasium ground has been fitted with frames to which will be attached apparatus similar to that in the men's gymnasium; this apparatus is completed in readiness for putting in place as soon as spring opens and the adjoining building is finished.

The men's gymnasium has been kept open throughout the year until December 13, when it closed for the winter. In April a counter was attached to the turnstile at the entrance, and from April 8 to December 13 there passed through the entrance, as shown by the counter, 95,602 persons, an average of 447 each day, not including Sundays.

Since the gymnasium was closed the apparatus has been dismantled, and all movable parts have been stored under cover.

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#### WIDTHS OF DRAW-OPENINGS.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in Appendix A. The openings have all been remeasured for this report.

WILLIAM JACKSON,  
*City Engineer.*



## CITY ENGINEERS.

1850-1891.

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E. S. CHESBROUGH, M. Am. Soc. C. E.,  
Nov. 18, 1850, to Oct, 1855.<sup>1</sup>

JAMES SLADE,  
Oct. 1, 1855, to April 1, 1863.<sup>2</sup>

N. HENRY CRAFTS,  
April 1, 1863, to Nov. 25, 1872.

JOSEPH P. DAVIS, M. Am. Soc. C. E.,  
Nov. 25, 1872, to March 20, 1880.<sup>3</sup>

HENRY M. WIGHTMAN, M. Am. Soc. C. E.,  
April 5, 1880, to April 3, 1885.<sup>4</sup>

WILLIAM JACKSON, M. Am. Soc. C. E.,  
April 21, 1885, to present time.

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<sup>1</sup> Died August 18, 1886.

<sup>2</sup> Died August 25, 1882.

<sup>3</sup> Resigned March 20, 1880.

<sup>4</sup> Died April 3, 1885.

## APPENDIX A.

Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1891.

NAME OF BRIDGES.	LOCATION.	NUMBER OF OPENINGS	WIDTH.	
			Feet.	In.
Boston & Maine R.R. . . . .	Boston to Charlestown . . . .	1	35	4
" " . . . . .	Over Miller's River . . . . .	1	35	9
Broadway . . . . .	Over Fort-Point Channel . . . .	1	43	3
Cambridge-st. . . . .	Ward 25 to Cambridge . . . . .	1	36	0
Canal . . . . .	Boston to East Cambridge . . . .	1	35	10
Charles-river . . . . .	Boston to Charlestown . . . . .	1	36	0
Chelsea (South Channel) . . . . .	Charlestown to Chelsea . . . . .	1	38	10
" (North " ) . . . . .	" " . . . . .	1	44	9
Chelsea-st. (East Boston side) . . . . .	East Boston to Chelsea . . . . .	2	33	1
" (Chelsea side) . . . . .	" " . . . . .		34	3
Commercial-point . . . . .	Ward 24 . . . . .	1	24	0
Congress-st. (Boston side) . . . . .	Over Fort-Point Channel . . . . .	2	43	3
" (So. Boston side) . . . . .	" " . . . . .		43	11
Dover-st. . . . .	" " . . . . .	1	36	0
Eastern R.R. . . . .	Boston to Charlestown . . . . .	1	35	10
" " . . . . .	Over Miller's River . . . . .	1	35	9
Essex-st . . . . .	Ward 25 to Cambridge . . . . .	1	36	0
Federal-st. . . . .	Over Fort-Point Channel . . . . .	1	36	0
Fitchburg R.R. . . . .	Boston to Charlestown . . . . .	1	36	0
" " (for teaming freight) . . . . .	" " . . . . .	1	36	0

Grand Junction R.R.	.	.	.	.	.	.	Ward 25 to Cambridge	.	1	35	0
"	"	.	.	.	.	.	East Boston to Chelsea	.	1	34	8
Granite	.	.	.	.	.	.	Ward 24 to Milton	.	1	36	0
Harvard (Boston side)	.	.	.	.	.	.	Boston to Cambridge	.	2	36	8
" (Cambridge side)	.	.	.	.	.	.	" "	.		36	8
Lowell R.R. (freight)	.	.	.	.	.	.	Boston to East Cambridge	.	1	35	8
" " (passenger)	.	.	.	.	.	.	" "	.	1	35	10
Malden	.	.	.	.	.	.	Charlestown to Everett	.	1	43	4
Meridian-st. (East Boston side)	.	.	.	.	.	.	East Boston to Chelsea	.	2	59	0
" (Chelsea side)	.	.	.	.	.	.	" "	.		59	0
Mt. Washington-ave. (Boston side)	.	.	.	.	.	.	Over Fort-Point Channel	.	2	42	1
" " (So. Boston side)	.	.	.	.	.	.	" "	.		42	4
Neponset	.	.	.	.	.	.	Ward 24 to Quincy	.	1	36	0
New York & New England R.R. (Boston side)	.	.	.	.	.	.	Over Fort-Point Channel	.	2	40	8
" " (So. Boston side)	.	.	.	.	.	.	" "	.		40	10
"	"	"	.	.	.	.	Over South Bay	.	1	28	4
North Beacon-st.	.	.	.	.	.	.	Ward 25 to Watertown	.	1	30	2
North Harvard-st.	.	.	.	.	.	.	Ward 25 to Cambridge	.	1	36	0
Old Colony R.R.	.	.	.	.	.	.	Over Fort-Point Channel	.	1	36	0
"	.	.	.	.	.	.	Ward 24 to Quincy	.	1	36	0
Prison-point	.	.	.	.	.	.	Charlestown to Cambridge	.	1	35	7
Warren	.	.	.	.	.	.	Boston to Charlestown	.	1	36	3
West Boston (Boston side)	.	.	.	.	.	.	Boston to Cambridge	.	2	35	8
" (Cambridge side)	.	.	.	.	.	.	" "	.		36	0
Western-ave.	.	.	.	.	.	.	Ward 25 to Cambridge	.	1	31	3
"	.	.	.	.	.	.	Ward 25 to Watertown	.	1	30	0



## APPENDIX B.

*City of Boston, Revised Ordinances 1890.*

## CHAPTER 13.

## ENGINEERING DEPARTMENT.

SECTION 1. The engineering department shall be under the charge of the city engineer, who shall be consulted on all matters relating to public improvements of every kind, where the advice of a civil engineer would be of service; shall, unless otherwise specially provided, take charge of the construction of all public works of the city which properly come under the direction of a civil engineer; shall perform all engineering services, and make all examinations and prepare all statements, plans, specifications, and contracts which any department, except the sewer department, may need in the discharge of its duties; shall, upon being notified by the superintendent of bridges, supervise all repairs on the bridges of the city used as highways, which affect the safety of the structures, and shall, when required by any officer or board in charge of a department, or by the mayor, measure the work done by contract for the city, and certify to the result of such measurement.

SECT. 2. Said engineer shall in his annual report include a report of the safety and completeness of all ponds, basins, and reservoirs under the charge of the water department and of all bridges within the city limits used as highways.

## APPENDIX C.

## ENGINEERING DEPARTMENT, PROPERTY SCHEDULE, MAIN OFFICE.

1 horse.	Photographs of Engineering Works.
2 carriages.	Apparatus for blue-printing.
1 sleigh.	1 microscope.
2 harnesses.	1 mercurial barometer.
3 robes.	1 aneroid barometer.
Instruments for surveying and drawing.	1 holosteric barometer.
Cases for plans and books.	1 set hydrometers.
Reference Library, 830 vols.	1 hygrometer.
7,945 Plans Engineering Works, loose.	1 pr. field-glasses.
14 vols. Plans Engineering Works, bound.	2 typewriters.

## IMPROVED SEWERAGE CONSTRUCTION.

## SCHEDULE OF PROPERTY IN CHARGE OF ENGINEERING DEPARTMENT.

3 adzes.	1 derrick, tripod.
2 augers.	5 desks.
13 axes.	2 dogs, sets.
1 bar, claw.	9 drills.
10 bars, crow.	1 duster.
1 bar, pinch.	2 drawing instruments, sets.
2 baskets.	3 drawing-tables.
6 belt lacings.	1 engine, Erie.
1 bookcase.	150 envelopes.
1 brand.	1 eraser.
6 brooms.	2 faucets.
1 brush, paint.	6 files.
5 buildings.	39 frames, manhole.
2 bags.	4 gaskets.
1 buggy.	3 glasses, water.
2 cant-hooks.	1 grindstone.
150 lbs. canvas.	28 gasoline lamps.
1 calking-iron.	$\frac{1}{2}$ bbl. gasoline.
9 chains.	1 harness.
15 chairs.	2 hammers, claw.
1 chuck hydrant.	3 hammers, sledge.
39 covers, manhole.	4 handles, adze.
2 cases of drawers.	10 handles, axe.
2 clocks.	28 handles, pick.
3 curtains.	1 hatchet.
3 cuspidores.	3 hods, coal.

3 hoes.	1 pump, hand.
150 ft. hose, hand.	3 pulleys.
24 ft. hose, suction.	1 pump, steam.
6 horses, wooden.	5 rammers.
60 ft. hose, steam.	36 rubber boots.
1 horse.	5 rubber coats.
4 inkstands.	3 rubber gloves.
400 ft. iron pipe.	3 rubber hats.
12 lamp chimneys.	6 rules.
24 lamp-wicks.	3 robes.
5 lamps.	2 sand heaters.
50 lanterns.	3 saws, cross-cut.
1 level.	2 saws, hand.
3 lines.	1 saw, set.
4 levels, engineers'.	3 bushels salt.
3 levelling-rods.	4 shears.
100 mats, straw.	42 shovels, common.
12 mauls.	4 shovels, stove.
1 measuring-rod.	3 steel tapes.
1 mirror.	5 stoves.
16 mounting-boards.	227 steps, manhole.
1 keg nails, cut.	5 sighting-rods.
25 lbs. oakum.	1 sleigh.
8 gal. oil, cylinder.	1 table, letter-press.
1 bbl. kerosene.	9 tapes, cloth.
4 oilers.	3 tool-boxes.
5 oil-barrels.	12 towels.
12 oil-suits.	1 trowel.
15 padlocks.	4 tunnels.
14 pails, cement.	3 transits.
4 pails, water.	1 testing-machine.
4 cans paint.	2 tables.
3 rolls paper, tarred.	12 washers.
4 pencils.	10 lbs. waste.
50 pens.	2 wedges, steel.
28 picks.	6 wheelbarrows.
1 pitchfork.	3 wrenches, monkey.
7 plum-bobs.	1 wrench, Stillson.
3 poker.	6 wrenches, alligator.
1 pile-driver.	4 wrenches, track.
2 presses, letter.	

## APPENDIX D.

CITY ENGINEER'S REPORTS, 1868-1890.<sup>1</sup>

Year.	Doc.	Year.	Doc.	Year.	Doc.
1868.....	22	1877.....	15	1884.....	55
1869-70.....	14	1878.....	20	1885.....	54
1871.....	15	1879.....	22	1886.....	41
1872-73.....	23	1880.....	33	1887.....	38
1874.....	20	1881.....	25	1888.....	39, 117
1875.....	19	1882.....	52	1889.....	38
1876.....	24	1883.....	53	1890.....	39

<sup>1</sup>The dates given are for the year in which the document was published.



## CONTENTS ENGINEERING DEPARTMENT REPORTS.

**1868-1890.<sup>1</sup>**

SUBJECT.	Year.	Doc.	Page.
<b>Adams-street bridge (over O. C. R.R.)</b> .....	1885	54	28
“ “ “ “ “ “ .....	1886	41	20
“ “ “ “ “ “ .....	1887	38	16
<b>Adams-street survey</b> .....	1868	22	29
<b>Additional water-supply</b> .....	1874	20	15
“ “ .....	1875	19	12
“ “ .....	1876	24	8
“ “ .....	1877	15	37
“ “ .....	1878	20	35
“ “ .....	1879	22	32
“ “ .....	1880	33	27
“ “ .....	1881	25	27
“ “ .....	1889	38	60
“ “ .....	1890	39	37
<b>Agassiz-road bridge (in B. B. Fens)</b> .....	1888	39	33
“ “ “ “ “ “ .....	1888	117	5
“ “ “ “ “ “ .....	1889	38	6, 64
“ “ “ “ “ “ .....	1890	39	7, 64
<b>Albany-street bridge (over B. &amp; A. R.R.)</b> .....	1868	22	21
“ “ “ “ “ “ .....	1870	14	37
“ “ “ “ “ “ .....	1871	15	69
“ “ “ “ “ “ .....	1873	23	46
“ “ “ “ “ “ .....	1874	20	35
“ “ “ “ “ “ .....	1875	19	38
“ “ “ “ “ “ .....	1876	24	32
“ “ “ “ “ “ .....	1877	15	24
“ “ “ “ “ “ .....	1878	20	26
“ “ “ “ “ “ .....	1879	22	22
“ “ “ “ “ “ .....	1880	33	17
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# ENGINEERING DEPARTMENT.

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TWENTY-FIFTH ANNUAL REPORT

OF THE

# CITY ENGINEER,

# BOSTON,

FOR THE YEAR 1891.

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Printed for the Department.



BOSTON :  
ROCKWELL AND CHURCHILL, CITY PRINTERS.  
1892.



ENGINEERING DEPARTMENT, CITY HALL,  
BOSTON, Feb. 1, 1892.

HON. NATHAN MATTHEWS, JR.,

*Mayor of the City of Boston:*

SIR: In compliance with the Revised Ordinances the following report of the expenses and operations of the department for the year 1891 is respectfully submitted:

The report of this department may be classified under the following heads:

A. — The examination and supervision of structural repairs of bridges, the designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council.

B. — Charge of the engineering work in connection with the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works.

C. — Charge of the construction of a system of intercepting and outlet sewers.

D. — Charge of the engineering work in connection with the parks.

E. — Charge of the engineering work, except for Sewer Division, in connection with the Street Department.

The expenses incurred under the head "C" are paid wholly from a special appropriation.

A.

The following is a statement of engineering expenses from January 1, 1891, to January 31, 1892:

Amount expended from department appropriation for 1890-91	\$9,633 69
Amount expended from department appropriation for 1891-92	26,989 69
Total	<hr/> \$36,623 38

**STATEMENT OF EXPENDITURES, DEPARTMENT APPROPRIATIONS.**

OBJECT OF EXPENDITURES.	1891. January to May 1.	1891. May to Jan- uary 31.	Total Expenditures, Jan. 1, 1891, to Jan. 31, 1892.
Salaries of City Engineer, assistants, draughtsmen, transitmen, level- lers, rodmen, etc. ....	\$8,547 06	\$24,465 22	\$33,012 28
Engineering instruments and re- pairs of same.....	72 10	914 74	986 84
Drawing-paper, and all materials for making plans.....	105 16	306 45	411 61
Stationery, printing-stock, note- books, postage, etc.....	164 10	222 22	386 32
Printing.....	146 19	99 40	245 59
Reference library, binding books, and photographs of works.....	184 20	170 25	354 45
Travelling expenses (including horse-keeping, repairs on vehi- cles, etc.).....	202 55	476 84	679 39
Telephone service.....	60 20	144 35	204 55
Furniture cases for plans and books, etc.....		30 00	30 00
Blue-process printing.....	151 25	2 50	153 75
Incidental expenses, and all other small supplies.....	50 88	157 72	208 60
<b>Totals.....</b>	<b>\$9,688 69</b>	<b>\$26,989 69</b>	<b>\$36,628 38</b>

## CHARLES-RIVER BRIDGES.

Appropriation . . . . . \$15,400 00

*Statement of Expenses from Jan. 1, 1891, to Jan. 31, 1892.*

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
Cambridge-st. bridge, A. McInnis, contractor, for widening draw- opening .....	\$1,125 00	\$941 27	\$2,066 27
Essex-st. bridge, W. A. Kenrick & Son, contractors, for widening draw-opening .....		3,500 00	3,500 00
North Harvard-st. bridge, John Cavanagh & Co., contractors, for widening draw-opening .....	1,106 72	.....	1,106 72
Western-ave. bridge, Wm. Miller, contractor, for widening draw- opening .....		3,714 00	3,714 00
Inspection .....	376 00	.....	376 00
Printing and stationery .....	34 54	.....	34 54
Lumber .....	14 35	.....	14 35
Ironwork .....	42 75	.....	42 75
Totals .....	\$2,699 86	\$8,155 27	\$10,854 63

Appropriation . . . . .		\$15,400 00
Expended previous to Jan. 1, 1891 . . . . .	\$3,383 19	
Expended from Jan. 1, 1891, to Jan. 31, 1892 . . . . .	10,854 63	
		<u>14,237 82</u>
Balance Feb. 1, 1892 . . . . .		\$1,162 18

## FEDERAL-STREET BRIDGE.

Appropriation . . . . . \$100,000 00

*Statement of Expenses from Jan. 1, 1891, to Jan. 31, 1892.*

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
Anti-friction rolls .....	\$340 00	.....	\$340 00
Carpenter work, pulling piles, etc.,	73 00	\$527 16	600 16
Dynamometer .....	36 00	.....	36 00
Engineering and inspection.....	939 58	991 75	1,931 33
Electric machinery .....	.....	3,871 69	3,871 69
Freight and coal .....	35 85	.....	35 85
Ironwork and hardware.....	346 36	989 19	1,335 55
Machinery for draws.....	.....	1,843 17	1,843 17
Pig-lead for counterbalance, and labor on same.....	1,543 46	1,258 77	2,802 23
Rent of hoisting-engine.....	230 00	427 50	657 50
Sidewalk and paving.....	150 00	112 39	262 39
Snatch-blocks, casks, and rope ....	105 23	40 42	145 65
Travelling expenses and postage...	11 89	5 82	17 71
Shaw & Miller, contractors for re- building .....	7,418 80	42,232 77	49,651 57
Pittsburg Bridge Co., contractors for iron draws.....	4,266 83	6,086 80	10,353 13
Charles Carr, contractor steel trucks.....	2,744 00	.....	2,744 00
<b>Totals.....</b>	<b>\$18,240 50</b>	<b>\$58,387 43</b>	<b>\$76,627 93</b>

Appropriation . . . . .	\$100,000 00
Expended previous to Jan. 1, 1891 . . . . .	\$22,657 24
Expended from Jan. 1, 1891, to Jan. 31, 1892 . . . . .	76,627 93
	<hr/> 99,285 17
Balance Feb. 1, 1892 . . . . .	\$714 83

## FERDINAND-STREET BRIDGE.

Appropriation . . . . . \$35,000 00

*Statement of Expenses from Jan. 1, 1891, to Jan. 31, 1892.*

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
Advertising.....	\$28 88	.....	\$28 88
Engineering and inspection.....	.....	\$575 00	575 00
Printing and stationery.....	58 12	.....	58 12
Travelling expenses....	18 88	6 30	25 18
Parapet stone.....	.....	20 00	20 00
Parapet and coping-stone, south abutment.....	.....	198 00	198 00
Cutting, coping, and building fence.....	.....	350 00	350 00
Teaming.....	.....	18 00	18 00
R. F. Hawkins, contractor, iron bridge.....	.....	4,096 45	4,096 45
R. D. Shanahan, contractor, retain- ing-wall.....	.....	4,321 38	4,321 38
Street department.....	.....	5,890 77	5,890 77
Totals .....	\$105 88	\$15,475 85	\$15,581 23

Appropriation . . . . .	\$35,000 00
Expended previous to Jan. 1, 1891,	\$43 80
Expended from Jan. 1, 1891, to Jan. 31, 1892 . . . . .	15,581 23
Transferred to Harvard bridge, June 2, 1891 . . . . .	10,000 00
Transferred to Milton bridge, Oct. 1, 1891 . . . . .	2,500 00
Transferred to West Newton street, paving, Oct. 5, 1891 . . . . .	5,000 00
	<hr/> 33,125 03
Balance Feb. 1, 1892 . . . . .	<hr/> \$1,874 97



## IMPROVED SEWERAGE.

Total appropriations . . . . . \$5,913,164 93

*Statement of Expenses, Improved Sewerage, Jan. 1, 1891, to Jan. 31, 1892.*

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
General Office expenses .....	\$8,916 20	\$9,818 56	\$18,729 76
Moon Island.....	990 75	.....	990 75
Pumping-station .....	180 00	.....	180 00
"    outside .....	985 00	.....	985 00
Sec. 1, Brighton, Int. Sewer.....	8 00	3,514 78	3,517 78
" 3, Dorchester, " " .....	1,532 98	.....	1,532 98
" 4, " " " " .....	2,075 83	1,369 84	3,445 67
" 5, " " " " .....	2,548 29	.....	2,548 29
" 6, " " " " .....	142 17	72 08	214 25
" 7, " " " " .....	.....	89 19	89 19
" 8, " " " " .....	.....	14,209 42	14,209 42
" 9, " " " " .....	.....	89 20	89 20
" 10, " " " " .....	12,402 66	28,565 60	40,968 26
" 5, 6, East side, " " .....	26,190 79	26,650 66	52,841 45
" 3, Outfall Sewer.....	1,018 15	55,441 89	56,460 04
" 7, South Boston, Int. Sewer..	383 89	.....	383 89
" 8, " " " " " " ..	150 00	23 72	173 72
" 9, " " " " " " ..	150 00	.....	150 00
Totals .....	\$52,669 71	\$139,739 94	\$192,409 65

Appropriations . . . . . \$5,913,164 93

Expended previous to Jan.  
1, 1891. . . . . \$5,672,836 76

Expended from Jan. 1,  
1891, to Jan. 31, 1892 . . . . . 192,409 65

5,865,246 41

Balance Feb. 1, 1892 . . . . . \$47,918 52

## BRIDGES.

The inspection of the highway bridges for the annual report of their safety and completeness has been made, and, as usual, besides the highway bridges, all such bridges as the Public Garden foot-bridge and the bridges in the Parks have also been inspected.

During the year twelve notifications have been received that bridges have been stripped preparatory to repairing the same, and when notified examinations have been made, plans furnished, and supervision of repairs made when necessary.

Federal-street bridge, which was being rebuilt when the last annual report was made, has been completed.

## LIST OF BRIDGES INSPECTED.

In the list those marked with an \* are over navigable water, and are each provided with a draw.

## I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Agassiz road, in Back Bay Fens.

Ashland street, Ward 23, over Providence Division Old Colony Railroad.

Athens street, over New York & New England Railroad.

Beacon Entrance, Back Bay Fens, over Boston & Albany Railroad.

Beacon street, over outlet to Back Bay Fens.

Beacon street, over Boston & Albany Railroad.

Berkeley street, over Boston & Albany Railroad.

Berkeley street, over Providence Division Old Colony Railroad.

Blakemore street, over Providence Division Old Colony Railroad, Ward 23.

Bolton street, over New York & New England Railroad.

Boylston street, in Back Bay Fens.

Boylston street, over Boston & Albany Railroad.

\*Broadway, over Fort Point Channel.

Broadway, over Boston & Albany Railroad.

Brookline avenue, over Boston & Albany Railroad.

Byron street, over Boston, Revere Beach, & Lynn Railroad.

\*Charles River, from Boston to Charlestown.

\*Chelsea (south), over South Channel, Mystic river.

\*Chelsea street, from East Boston to Chelsea.

Columbus avenue, over Boston & Albany Railroad.

\*Commercial Point, or Tenean, Ward 24.

- Commonwealth avenue, in Back Bay Fens.  
 \*Congress street, over Fort Point Channel.  
 Cottage-street foot-bridge, over Flats, East Boston.  
 Cornwall street, over Stony Brook, Ward 23.  
 Dartmouth street, over Boston & Albany and Providence  
 Division Old Colony Railroad.  
 \*Dover street, over Fort Point Channel.  
 \*Federal street, over Fort Point Channel.  
 Fen, Back Bay Fens.  
 Ferdinand street, over Boston & Albany Railroad.  
 Franklin-street foot-bridge, over Boston & Albany Rail-  
 road.  
 Gold street, over New York & New England Railroad.  
 Huntington avenue, over Boston & Albany Railroad.  
 Irvington street, over Providence Division, Old Colony  
 Railroad.  
 Leyden street, over Boston, Revere Beach, & Lynn Rail-  
 road.  
 Linden Park street, over Stony brook.  
 \*Malden, from Charlestown to Everett.  
 \*Meridian street, from East Boston to Chelsea.  
 \*Mt. Washington avenue, over Fort Point Channel.  
 Neptune road, over Boston, Revere Beach, & Lynn Rail-  
 road.  
 Newton street, over Providence Division Old Colony Rail-  
 road.  
 Public Garden foot-bridge.  
 Shawmut avenue, over Boston & Albany Railroad.  
 Stony brook, Back Bay Fens.  
 Swett street, east of New York & New England Railroad.  
 Swett street, west of New York & New England Railroad.  
 \*Warren, from Boston to Charlestown.  
 West Chester park, over Boston & Albany Railroad.  
 West Chester park, over Providence Division Old Colony  
 Railroad.  
 West Rutland square foot-bridge, over Providence Divi-  
 sion Old Colony Railroad.  
 Winthrop, from Breed's Island to Winthrop.

## II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

- \*Cambridge street, from Brighton to Cambridge.  
 Central avenue, from Ward 24 to Milton.  
 \*Chelsea (north), from Charlestown to Chelsea.  
 \*Essex street, from Ward 25 (Brookline) to Cambridge.  
 \*Granite, from Dorchester, Ward 24, to Milton.

Longwood avenue, from Ward 22 to Brookline.  
 Mattapan, from Ward 24 to Milton.  
 Milton, from Ward 24 to Milton.  
 \*Neponset, from Ward 24 to Quincy.  
 \*North Beacon street, from Brighton to Watertown.  
 \*North Harvard street, from Brighton to Cambridge.  
 Spring street, from West Roxbury to Dedham.  
 \*Western avenue, from Brighton to Cambridge.  
 \*Western avenue, from Brighton to Watertown.

### III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

Albany street, over Boston & Albany Railroad.  
 \*Canal, from Boston to Cambridge.  
 Dorchester street, over Old Colony Railroad.  
 \*Harvard, from Boston to Cambridge.  
 \*Prison Point, from Charlestown to Cambridge.  
 \*West Boston, from Boston to Cambridge.

### IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

#### *1st. — Boston & Albany Railroad.*

Commonwealth avenue, Brighton.  
 Harrison avenue.  
 Market street, Brighton.  
 Tremont street.  
 Washington street.

#### *2d. — Boston & Maine Railroad, Western Division.*

Mystic avenue.  
 Main street.

#### *3d. — Boston & Maine Railroad, Eastern Division.*

Mystic avenue.  
 Main street.

#### *4th. — Boston, Revere Beach, & Lynn Railroad.*

Everett street.

#### *5th. — New York & New England Railroad.*

Broadway.  
 Dorchester avenue.  
 Fifth street.  
 Forest Hills avenue, Ward 24.

Fourth street.  
 Harvard street, Ward 24.  
 Norfolk " " "  
 Norfolk " " "  
 Second street.  
 Silver street.  
 Sixth street.  
 Third street.  
 Washington street, Ward 24.

*6th. — Old Colony Railroad.*

Adams street.  
 Ashmont street and Dorchester avenue.  
 Cedar Grove Cemetery.  
 Commercial street.  
 Savin Hill avenue.

*7th. — Old Colony Railroad, Providence Division.*

Beech street, Ward 23.  
 Bellevue street, Ward 23.  
 Canterbury street, Ward 23.  
 Centre street, or Hog Bridge, Ward 23.  
 Centre and Mt. Vernon streets, Ward 23.  
 Dudley avenue, Ward 23.  
 Park street, Ward 23.

RECAPITULATION.

I.	Number wholly supported by Boston . . . . .	51
II.	Number of which Boston supports the part within its limits . . . . .	14
III.	Number of which Boston pays a part of the cost of maintenance . . . . .	6
IV.	Number supported by railroad corporations :	
1.	Boston & Albany . . . . .	5
2.	Boston & Maine, Western Division . . . . .	2
3.	" " Eastern Division . . . . .	2
4.	Boston, Revere Beach, & Lynn . . . . .	1
5.	New York & New England . . . . .	13
6.	Old Colony . . . . .	5
7.	" " Providence Division . . . . .	7
	Total number . . . . .	106

Four bridges have been added to the list this year, namely :

Cornwall street, over Stony brook, Ward 23 ; Irvington street foot-bridge, over the Providence Division of the Old Colony Railroad ; and two bridges in the Back Bay Fens, viz., the Fen bridge, and the Stony-brook bridge over the new outlet to Stony brook.

## I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

### AGASSIZ-ROAD BRIDGE IN BACK BAY FENS.

This bridge was built in 1887, of brick and stone masonry. It is maintained by the Park Department, and is in good condition.

### ASHLAND-STREET BRIDGE (OVER PROVIDENCE DIVISION OLD COLONY RAILROAD, WARD 23).

The present structure is of iron, and was built in 1875. The ironwork and fences should be painted ; otherwise it is in good condition.

### ATHENS-STREET BRIDGE (OVER NEW YORK & NEW ENGLAND RAILROAD).

This is an iron bridge, and was built in 1874. The ironwork is badly rusted and is in bad condition. The recommendation of last year is renewed, "that the ironwork be stripped and painted."

### BEACON-ENTRANCE BRIDGE (IN BACK BAY FENS, OVER BOSTON & ALBANY RAILROAD).

This is an iron bridge, and was built in 1881-82.

It is maintained by the Park Department, and is in good condition. It has been painted.

### BEACON-STREET BRIDGE (OVER OUTLET OF BACK BAY).

This is an iron bridge, built in 1880-81. The ironwork should be painted, otherwise the bridge is in good condition.

### BEACON-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This is an iron bridge ; it was built in 1884-85 ; it was widened in 1887-88, and the central roadway was widened a few feet for the accommodation of the cars of the West End Street Railway Co., at the expense of that corporation.

The bridge is in good condition.

**BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

In process of rebuilding. (See page 90.)

**BERKELEY-STREET BRIDGE (OVER PROVIDENCE DIVISION  
OLD COLONY RAILROAD).**

The spans over the main track have not been stripped since 1879. At that time the iron beams were found to be somewhat wasted by rust, and intermediate wooden beams were added.

So far as can be seen the wooden beams are in good condition, but it is recommended that this part of the bridge be stripped so that it may be more carefully examined.

The remainder of the bridge is in fair condition.

A movement has been made toward replacing a portion of the bridge by longer spans in order to make both the highway and the railroad more safe, and also to better accommodate the railroad.

**BLAKEMORE-STREET BRIDGE (OVER PROVIDENCE DIVISION  
OLD COLONY RAILROAD).**

This is an iron bridge. It was built in 1881-82. It is in good condition.

**BOLTON-STREET BRIDGE (OVER NEW YORK & NEW  
ENGLAND RAILROAD).**

This is a new wooden bridge. It is in good condition.

**BOYLSTON-STREET ARCH BRIDGE (IN BACK BAY FENS).**

The small cracks in the masonry and parapet which have existed since the bridge was built, still open slightly after pointing. They have no significance except as an indication that the whole area around the bridge still continues to settle at a slow rate. The bridge is in good condition.

**BOYLSTON-STREET BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge. It was built in 1886-88.

An ornamental railing, extending over the adjoining retaining-walls should be provided in place of the present temporary fence.

No repairs have been needed, and the bridge is in good condition.

**\* BROADWAY BRIDGE (OVER FORT POINT CHANNEL).**

This is an iron bridge. It was built in 1869-71, and the draw and its foundation were rebuilt in 1874-75.

The floor-beams on the 100-ft. span are crooked and out of plumb; they were originally weak, and appear to be even worse than they actually are.

The main trusses over Foundry and Lehigh streets are out of plumb, and are weak. Estimates have been made for renewing the 100-ft. span, and the spans over Foundry and Lehigh streets, and for strengthening the column sections of the bridge so as to make the structure strong enough to carry the long electric cars now used by the West End Street Railway Co.

The sidewalks are in poor condition; the concrete should be repaired, and the under floor patched where necessary.

The draw-pier is in good condition, so far as it can be seen, but it has not been examined by a diver to ascertain the amount of damage done by Limnoria. The examination of two years ago showed extensive damage already done, and further examination should be made next summer.

**BROADWAY BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This bridge is of iron, and was built in 1880-81.

The ironwork is very rusty.

The bridge should be stripped of woodwork, cleaned, and painted.

**BROOKLINE-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD.)**

This bridge is of iron, and was built in 1884. It is in good condition.

**BYRON-STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD).**

This is a wooden bridge. It was built in 1889. It is in good condition.

**\* CHARLES-RIVER BRIDGE (FROM BOSTON TO CHARLESTOWN).**

This is a wooden pile bridge with an iron draw. The original bridge was built in 1785-86; the present structure was built in 1854-55; the draw was built in 1870.

The down-stream pier is in bad condition; the lower end has been forced out of place from one to two feet, and yields



as much more when struck by vessels. The fender-guard is in a ruinous condition.

The sag in the bridge toward the east is more considerable than heretofore, and unless the cross-bracing before recommended is soon applied, it will become dangerous. Several buildings belonging to private parties and attached to the bridge are in precarious condition for lack of suitable foundation.

The floor timbers of the draw are in bad condition. A picket fence has been built in place of the old rails on the draw, to prevent persons from going under the draw; an unidentified tramp having been killed by so doing.

Estimates have been made for rebuilding the bridge.

**\* CHELSEA BRIDGE, SOUTH (OVER SOUTH CHANNEL, MYSTIC RIVER).**

This is a pile bridge with an iron draw. The original bridge was built in 1802-3, and the present structure in 1876-77.

Apparatus has been provided for moving the draw by steam.

The bridge needs a few ordinary repairs, but is in good condition as a whole.

**\* CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA.)**

This is a wooden pile bridge; was originally built in 1834; was rebuilt in 1848, and again rebuilt in 1873, and the present draw was built in 1868.

The part of the bridge between the draw and Chelsea was burned in 1887, and rebuilt in a temporary manner, and the draw is so low that it will be necessary to raise the grade of the whole bridge when a new draw is built.

Estimates for rebuilding this bridge was made in 1889. It is narrow and inconvenient, and the draw and its foundation are in a dangerous condition. The travel over the bridge is increasing, and the passage of vessels through the draw is increasing. It is a dangerous bridge, and its rebuilding should not be delayed.

**COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, was originally built in 1865, and the present structure was built in 1876-77.

The bridge is in good condition, except that it is made a

point of attachment for telephone pole guys, and one truss has its upper chord thrown out of line by the strain. The guys should not be allowed to remain.

**\* COMMERCIAL-POINT, OR TENEAN, BRIDGE (WARD 24).**

This is a wooden pile bridge, with a wooden leaf draw. It was originally built in 1833, and the present structure was built in 1875.

This bridge requires repairs, and probably some of the main beams of the draws will have to be renewed next season.

**COMMONWEALTH-AVENUE BRIDGE (IN BACK BAY FENS).**

This is an iron bridge, and it was built in 1881-82. The ironwork needs painting; otherwise it is in good condition.

**\* CONGRESS-STREET BRIDGE (OVER FORT POINT CHANNEL).**

This is a wooden pile bridge with an iron turn-table draw on a stone masonry foundation. It was built in 1874-75. The fenders are in bad condition, and the heads of exposed spur shores are in some cases rotten. The floor of the main bridge has been patched, and requires more repairs of the same kind. The surface of the sidewalks should be renewed and the under floor patched. A long piece of the sidewalk was removed for the construction of a building on the south side at the city end of the bridge.

A defective main pile was discovered and reported, and the kyanized spruce covering plank on the draw-pier is commencing to decay.

**CORNWALL-STREET BRIDGE (OVER STONY BROOK, WARD 23).**

This small wooden bridge was built this year. (See page 91.)

**COTTAGE-STREET FOOT-BRIDGE (OVER FLATS, EAST BOSTON).**

This is a new wooden pile bridge, built in 1889 for foot travel only. It is in good condition.

**DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND PROVIDENCE DIVISION OLD COLONY RAILROAD).**

This is an iron bridge; it was built of wood in 1869, and the present structure was built in 1878-79. It is in good condition.

**\* DOVER-STREET BRIDGE (OVER FORT POINT CHANNEL).**

This is a wooden pile bridge with a double iron draw; it was originally built in 1805, was rebuilt in 1858-59, and the present structure was built in 1876. The concrete sidewalk is in poor condition. A considerable part of it should be relaid, and the woodwork beneath it repaired. The main floor of the roadway should be carefully examined by removing portions of the paving. It is known to be more or less decayed.

The channel was partially widened several years since to a width of 36 feet, but the work was never completed, and now, at about the level of low water, it is less than that width (which is the legal width of the draw-opening for the bridge). The track timber of the draw and the fender-guard have been repaired.

**\* FEDERAL-STREET (OVER FORT POINT CHANNEL).**

This bridge was originally built in 1827-28; was rebuilt in 1857-58, was again rebuilt in 1872-73, and the present structure, which is a wooden pile bridge with a double iron draw, was built during the past two years. It is in good condition. (See page 33.)

**FEN BRIDGE (BACK BAY FENS).**

This new bridge is nearly finished, and can soon be opened to travel.

**FERDINAND-STREET (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge. It was originally built in 1864-65, and was strengthened in 1877. The old structure has been removed and replaced by a new bridge. It is in good condition. (See page 35.)

**FRANKLIN-STREET FOOT-BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge, and was built in 1883. New wooden treads for the stairs are needed, and the bridge should be painted.

**GOLD-STREET FOOT-BRIDGE (OVER NEW YORK AND NEW ENGLAND RAILROAD).**

This is a wooden foot-bridge built in 1890.

This bridge is in good condition.

**HUNTINGTON-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge. It was built in 1872, and the abutments were rebuilt in 1876-77.

The wing-walls of the abutments should be pointed. The bridge is in good condition, but its surface should be regulated so as to conform to a proper grade of the approaches.

**IRVINGTON-STREET FOOT-BRIDGE (OVER PROVIDENCE DIVISION OLD COLONY RAILROAD).**

This is a new bridge built this year. (See page 91.)

**LEYDEN-STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD).**

This is an iron bridge, built in 1889. It needs painting; otherwise it is in good condition.

**\*MALDEN BRIDGE (FROM CHARLESTOWN TO EVERETT).**

The original bridge was built in 1787. The present structure was built in 1875, and the draw was built in 1872.

The draw-pier and the face of the water-way through the bridge are in bad condition. The draw is very old for a wooden structure; the wood is decayed in many places, the cross-beam, which carries the weight of both trusses to the centre is weak, and the draw-foundation is in poor condition.

Two bents of piles in the fixed part of the bridge, which rest on an old crib, are settling, and should be repaired in the spring. Estimates have been made for building a new draw.

**\*MERIDIAN-STREET BRIDGE (FROM EAST BOSTON TO  
CHELSEA).**

This is a wooden pile bridge with a wooden turn-table draw on a pile foundation. The original structure was built in 1856. It was rebuilt soon afterwards; was widened and rebuilt as at present in 1884, excepting the draw, which was built in 1875-76.

The bridge has been painted, and is in good condition.

**\*MT. WASHINGTON-AVENUE BRIDGE (OVER FORT POINT  
CHANNEL).**

This is a wooden pile bridge with an iron draw. It was built in 1854, and was rebuilt in 1870-71.

The turn-table of the draw has been repaired. The deck of the draw newly planked with hard-pine and calked, and the bridge painted. The draw-pier is so low that high tides cover it. The draw-tender's house has been enlarged and refitted. The waterways need replanking in part.

**NEPTUNE-ROAD BRIDGE (OVER REVERE BEACH & LYNN  
RAILROAD IN EAST BOSTON).**

This is an iron bridge, and it was built in 1887-88.  
It is maintained by the Park Department.  
It needs painting; otherwise it is in good condition.

**NEWTON-STREET BRIDGE (OVER PROVIDENCE DIVISION OLD  
COLONY RAILROAD.)**

This is an iron bridge, and was built in 1872.  
It is in good condition.

**PUBLIC GARDEN FOOT-BRIDGE.**

This is an iron bridge. It was built in 1867, and was thoroughly repaired in 1887.

The floor is worn and needs renewal; otherwise it is in good condition.

**SHAWMUT-AVENUE BRIDGE (OVER BOSTON & ALBANY  
RAILROAD).**

This is an iron bridge, and it was built in 1871.

The electric-wire poles of the West End Street Railway Co. are so placed as to make an unsightly bend in the ornamental parapet. The structure of the bridge is in good condition.

**STONY-BROOK BRIDGE (BACK BAY FENS).**

This is a new bridge, now in process of construction.  
(See page 74.)

**SWETT-STREET BRIDGES (OVER SOUTH BAY SLUICES).**

These are wooden bridges, and were built in 1875.

The easterly bridge is in safe condition, and the repairs recommended on the westerly bridge have been made.

The bulkhead wings to both bridges are in bad condition, but they still continue to serve their purpose.

**\*WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).**

This is a wooden pile bridge with an iron draw; it was originally built in 1828, and the present structure was built in 1883-84.

The fender-guard has been repaired. The kyanized spruce plank on the draw-pier, laid seven years ago, has commenced to decay, and will require patching.

The concrete sidewalk on the down-stream side of the bridge should be resurfaced. As a whole the bridge is in good condition.

**WEST CHESTER PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).**

This is an iron bridge, and was built in 1876.

It is in good condition. The grade of the surface of the bridge and approaches should be improved, as recommended for Huntington-avenue bridge.

**WEST CHESTER PARK BRIDGE (OVER PROVIDENCE DIVISION OLD COLONY RAILROAD).**

This is an iron bridge, and it was built in 1876.

It is in good condition.

**WEST RUTLAND-SQUARE FOOT-BRIDGE (OVER PROVIDENCE DIVISION OLD COLONY RAILROAD).**

This is an iron bridge; it was built in 1882, and is in good condition.

It should be painted.

**WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP).**

This is a pile bridge without a draw; it was originally built in 1839, was rebuilt in 1851, and was extensively repaired in 1870.

The bridge is old and poor, but is still in a safe condition.

## II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

### \*CAMBRIDGE-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).

This is a wooden pile bridge with a wooden leaf draw. It was rebuilt in 1884.

The work of widening the passageway for vessels, which was in progress under the supervision of the City Engineer of Cambridge at the date of the last report, has been completed.

The division of the cost between the two cities has not yet been finally adjusted, but the total cost will fall within the appropriation of \$15,400 made by the city of Boston for the four bridges over the Charles river; namely, Cambridge street, Western avenue to Cambridge, North Harvard street, and Essex street.

The draw-pier has been lengthened slightly and planked. The bridge is in good condition.

### CENTRAL-AVENUE BRIDGE (OVER NEPONSET RIVER, DOR- CHESTER LOWER MILLS).

This is an iron bridge, and was built in 1876. It is in good condition.

### \*CHELSEA BRIDGE, NORTH (FROM MYSTIC-RIVER CORPORA- TION WHARF TO CHELSEA).

The original structure was built in 1802-3; the present structure was built in 1880, except the draw, which was built in 1873.

Apparatus has been provided for moving the draw by steam. The fixed part of the bridge is in fair condition. The arrangements for draining the gravel under the paving do not work well, and water continues to drip over the outer stringers for a long time after rain. The draw and draw foundation are in poor condition.

The cluster of piles under the draw pivot should be spliced, and there is much rotten wood in the draw. It should be partially stripped and the defective parts removed.

### \*ESSEX-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).

This is a wooden pile bridge with a wooden leaf draw, and was originally built in 1850.

The work of widening the waterway has been completed, and the draw is in good condition, except that it needs replanking; a new sidewalk has been built.

The bridge as a whole is old and poor and should be rebuilt, as a natural consequence of the widening of Commonwealth avenue, so as to cross the Grand Junction Railroad above grade. (See page 38.)

**\*GRANITE BRIDGE (FROM WARD 24 TO MILTON).**

This bridge was originally built in 1837. It is a wooden pile bridge with a wooden leaf draw.

The draw-piers are not well placed with reference to the course of the river and the direction of the current, consequently great difficulty is found in passing vessels through there, and travel over the bridge is delayed by the long time required to pass vessels of large size.

**LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOKLINE).**

The present structure was built in 1877. This is a wooden bridge on wooden posts set in the ground.

The posts which carry the bridge are decaying near the surface of the ground. They should be put in order; otherwise the bridge is in good condition.

**MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).**

This is an old iron bridge; it is in a dangerous condition. It should be replaced by a stone bridge.

**MILTON BRIDGE (FROM WARD 24 TO MILTON).**

The original structure is very old; it was widened in 1871-72. The older part of this bridge was built of stone, and the widening is an iron structure on stone columns. The floor of this bridge has been repaired and the fences painted. It is in fair condition.

**\*NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).**

The original structure was built in 1802; the present structure in 1877.

The lower pier has been planked and a new sidewalk built. The bridge is in fair condition. The ironwork should be painted.



**\*NORTH BEACON-STREET BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge with a wooden leaf draw. The original structure was built in 1822, and the present structure in 1884. It is in fair condition.

Estimates have been made for rebuilding and widening the waterways of the bridge, and the next lower one on the river, namely, Western avenue to Watertown, the expense to be divided between Boston and Watertown.

**\*NORTH HARVARD-STREET BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

This bridge was originally built in 1662, and was rebuilt in 1879.

The work of widening the waterway to 36 feet has been completed, and a new shelter for the draw-tender built. The abutment is in poor condition. (See page 38.)

**SPRING-STREET BRIDGE (FROM WARD 23 TO DEDHAM).**

This is a stone bridge, and it is in good condition, except that the rail on the bridge is too low.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO CAMBRIDGE).**

The original structure was built in 1824; the present structure was built in 1879-80. The waterway has been widened to 36 feet under the supervision of the City Engineer of Cambridge. The pier needs planking. The draw should be adjusted and made to run easier than at present.

**\*WESTERN-AVENUE BRIDGE (FROM BRIGHTON TO WATERTOWN).**

This is a wooden pile bridge. It was built in 1824, the present draw was built in 1883, and the abutment was rebuilt in 1886. It is in good condition. As before stated under head of "North Beacon Street bridge," estimates have been made for rebuilding the bridge and widening the passageway for vessels.

### III.— BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

#### ALBANY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

The original structure was built in 1856-57; was rebuilt in 1867-68, and again in 1886-87.

It is in good condition.

#### \*CANAL BRIDGE (FROM BOSTON TO CAMBRIDGE).

#### \*PRISON-POINT BRIDGE (FROM CHARLESTOWN TO CAMBRIDGE.

#### \*WEST BOSTON BRIDGE (FROM BOSTON TO CAMBRIDGE.)

These bridges are in the care of two commissioners, appointed, one from Boston and one from Cambridge, and the expense of maintenance is borne equally by each city. The commissioner for the city of Boston is the Superintendent of Streets.

#### WEST BOSTON BRIDGE.

This is a wooden pile bridge with an iron turn-table draw. The bridge was originally built in 1792-93, was rebuilt in 1854, and repaired in 1871. The draw was rebuilt in 1875.

The repairs of the westerly bulkhead, sidewalk, and adjacent roadway, recommended as necessary in the last report, have been made.

Substantially the same plan was adopted as that used in repairing the opposite side of the bridge in 1886. The bridge has been relieved of a large and useless weight of gravel and mud, all decayed timber has been removed, a new sidewalk of hard-pine timber and kyanized spruce plank has been built, and upon it a brick sidewalk, laid in sand, was laid. The old edgestones have been reset, the roadway plank, wherever uncovered, has been protected by a layer of salt mud, and the roadway between the curbstone and street-railroad track has been repaired, using the old paving-blocks.

The part of the bridge repaired as above described includes all the up-stream sidewalk between the draw and the Cambridge abutment, and about one hundred feet in length on the same side of the bridge next the Boston abutment.

Bids were advertised for and the contract was awarded to Josiah Shaw, the lowest bidder.

Total cost, \$10,520.50, of which city of Boston paid one-half.

A new boiler for the engine turning the draw has been provided, and the turning apparatus put in good order. The up-stream end of the draw-pier is in bad condition, and will require to be repaired and strengthened. The plank sides of the waterway are in bad condition, and require immediate attention.

The paving of the roadway and sidewalks from the draw to the Boston end, and the bulkheads next the Charles-river embankment, should be repaired. With the exceptions above noted the bridge is in as good condition as it is practicable to put so old and narrow a structure. The need of a new and wider bridge becomes more apparent year by year.

#### CANAL, OR CRAIGIE'S BRIDGE.

This is a wooden pile bridge, with a wooden turn-table draw. The bridge was originally built in 1808, was rebuilt in 1852, and again rebuilt and widened in 1874. Some of the piles in this bridge date from 1808.

The foundation to the engine-house on the draw-pier has been put in good condition. A portion of the roadway paving was relaid last year; the remaining surface should be repaired.

The fender on the up-stream side is in bad condition. The hard bottom prevents the driving of piles in the usual manner, and a different plan must be adopted to protect the bridge from vessels. The sides of the waterway need new planking.

The wooden draw shows signs of age, and the piling under the Boston end will soon require attention. The bridge as a whole is in fairly good and safe condition.

#### PRISON-POINT BRIDGE.

This bridge was originally built in 1833, and the present structure was built in 1876-77. It is a wooden pile bridge, with an iron leaf draw.

The draw-pier has been replanked, and necessary repairs made to the roadway and machinery for moving the draw.

#### DORCHESTER-STREET BRIDGE (OVER OLD COLONY RAILROAD).

This is an iron bridge; it was built in 1869.

This bridge is principally supported by the Old Colony Railroad. No repairs have been made upon it. In last

year's report the following statement was made: "The bridge has not been stripped and painted for ten years. It is known to be in bad condition, just how bad cannot be ascertained without removing all the woodwork. It should be thoroughly overhauled in the spring." Nothing has yet been done.

**\*HARVARD BRIDGE (FROM BOSTON TO CAMBRIDGE).**

This bridge is practically completed, and was opened for travel Sept. 1, 1891. It is still in the hands of the commission by which it was built.

The bridge is built across the Charles river, and connects West Chester park, in Boston, with Front street, in Cambridge.

The length of the bridge between centres of bearings on abutments is 2,164 ft. 9 in.; the distance between harbor lines, measured at centre line of bridge, being 2,159 ft. 4½ in.

The bridge is a deck bridge, its width, excepting at and near draw, being 69 ft. 4 in. measured between centre of railings. This width is divided into one roadway 51 ft. wide, and two sidewalks each 9 ft. 2 in. wide.

The draw is 48 ft. 4 in. wide between centres of railings, the width of roadway being 34 ft. 6 in. and the width of each sidewalk 6 ft. 11 in. The elevations of roadway curb on bridge, above Boston city base, are 21 ft. at abutments, and increase to 29.5 ft. at piers 6 and 17, the bridge being level between these two piers.

The requirements to be fulfilled in the design of the bridge were such that only spans of moderate length could be used, and as built, the bridge is composed of fixed and suspended spans, generally 75 ft. 2½ in. long, with piers averaging 90 ft. 3 in. between centre.

The bed of the river at the bridge is generally composed of a deposit of mud and other soft material, overlying clay of varying consistency, excepting near the ends of the bridge, where gravel is found.

The substructure consists of two masonry abutments, twenty-three masonry piers, and one pile foundation and fender-pier for draw-span.

The foundations for the abutments and masonry piers were built on the same general plan. The bottom of the river was excavated by dredging to such depths and over such areas, at and about the proposed foundations, as was thought expedient, in the case of the abutment foundations the dredging being carried to 4 feet below city base, and to

depths varying from 3 ft. to 15 ft. for the pier foundations, the depths being determined by the amount of soft material at the pier.

The Boston abutment, and all piers, excepting Nos. 21, 22, and 23, rest on piles. These piles are sound and straight spruce piles, not less than 6 in. diameter at the point, and of such size at the butt that, when cut off at grade, one-half of them were 10 in. diameter, and the balance not less than 9 in. diameter. All measurements of piles were taken under the bark. The piles under the abutment were driven vertically, but under the piers the outside rows were driven with an inclination of one horizontal to twenty vertical.

All piles were cut off at a point about 2 ft. below city base, a slight variation in the levels of the tops of the piles being allowed. After the piles were driven a sheet-pile curbing was constructed about the space to be occupied by the foundation, the curbing being built with its top at grade 6 ft. above city base, or at about half-way between average high and low tide.

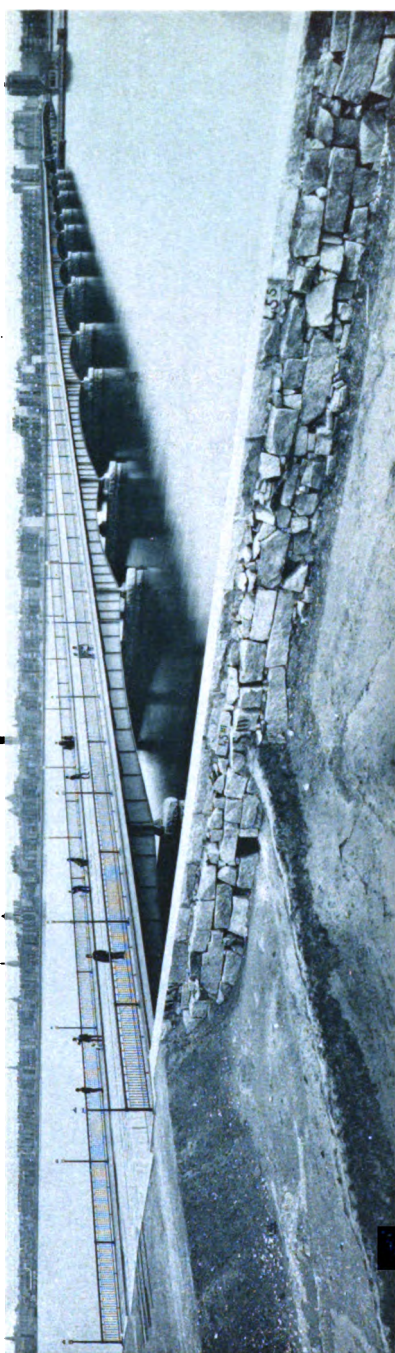
The purpose of this curbing was to form an inexpensive coffer-dam for "half-tide" work, in constructing the concrete base and stonework, and also when partially removed by cutting off at grade .83 ft., to retain the material under and about the piles and to protect the concrete base.

The space enclosed by the sheet-pile curbing was filled with concrete to grade 0, the concrete below grade 1 below city base being deposited around and on top of the piles through large sheet-iron pipes. No dumping of concrete into the water was allowed.

The concrete so deposited formed a water-tight bottom to the curbing or coffer-dam, and the balance, or upper foot in thickness, of the concrete was carefully deposited in place and levelled while the coffer-dam was free from water.

The concrete was made of one part of Portland cement, two parts of sand, and five parts of broken stone or pebbles from  $\frac{1}{4}$  in. to  $2\frac{1}{2}$  in. in their greatest diameter; all parts by measure.

The concrete foundations of the Cambridge abutment, and of piers 21, 22, and 23, rest directly upon the gravel bottom. The abutment masonry is of granite laid in American cement mortar, made of one part of cement and two parts of sand. The stones in the faces of the abutments are large rectangular blocks, laid in six courses, varying from 21 in. to 24 in. in thickness, the stones in each course being of equal rise. The stones are laid with 1-in. horizontal and vertical face joints. About one-fifth of the face area of the wall is



D. W. SUTTERFIELD, PHOTOGRAPHER, CAMBRIDGE, MASS.

## HARVARD BRIDGE.



composed of headers not less than five feet in depth. Face stones are quarry-faced, full and pitched to line, without drill or dog holes, and with no projections of more than 3 in., and no hollow faces. Backing is of large rubble-stones well bonded to face-stones.

Bridge-seat courses are rough-hammered on top and laid with  $\frac{3}{4}$ -in. vertical joints and 1-in. horizontal or bed joints. Front of course is quarry-faced, pitched to line. Parapet-courses are rough-hammered on all exposed surfaces, and laid with  $\frac{3}{4}$ -in. joints throughout.

All face joints in the abutments are pointed with Portland cement mortar for a depth of  $2\frac{1}{2}$  in.

The pier masonry is of granite laid in Portland cement mortar, made of one part of cement and two parts of sand.

The thickness of the piers, at bottom, is 6 ft. 9 in., and at top 4 ft. 0 in. to 4 ft. 6 in., according to height of pier. The lower, or foundation, course is made of headers extending the entire thickness of the pier. The beds of this course are dressed to lay not more than 1-in. joints, the builds dressed to lay  $\frac{3}{4}$ -in. joints, and the vertical joints dressed for  $\frac{3}{4}$ -in. joints, for one foot from faces of piers, the balance of vertical joints being from 1 in. to  $1\frac{1}{2}$  in. wide. The end stones of the foundation-course are of special shape.

The rise of courses in the piers, between the concrete foundation and the coping-course, is as follows: For piers 4 and 19, 2 ft. 3 in.; for all other piers the lower two courses are 2 ft. 3 in., and the remaining courses 2 ft. 0 in. The courses above the bottom or header course are of ashler masonry, laid in "Flemish bond," with special stones and bond at the ends of the piers.

The stretchers are not less than 6 ft. long, excepting at ends of piers, and are not less than 23 in. wide where the piers are 4 ft. thick, and not less than 2 ft. wide where the thickness of the piers exceed 4 ft., the face batter being included in these widths. The end vertical joints for a distance of one foot from face of pier, and the beds and builds, are dressed to lay  $\frac{3}{4}$ -in. joints; the back is quarry-split. The headers extend through the pier and are not less than 2 ft. wide, and have beds, builds, and one foot of vertical joints, from face of pier, dressed for  $\frac{3}{4}$ -in. joints. Pier faces of stones are quarry-faced, with no projections of more than 3 in., and no hollow faces; they are pitched to line and batter required. The pointed ends of piers are cut with a  $1\frac{1}{2}$ -in. chisel draft on each side of pier.

The spaces between the stones of the stretcher-courses are filled with concrete of the same kind as used in the foundation. The coping-course is 2 ft. thick, and is from



4 ft. 9 in. to 5 ft. 3 in. wide, according to width of pier. The stones of these courses are dressed for  $\frac{3}{8}$ -in. bed and vertical joints, and are rough-hammered full to line on top. Faces are quarry-faced, pitched to line, and show no drill or dog holes.

End stones are dowelled to stones below with  $1\frac{1}{4}$ -in. iron dowels set in neat cement mortar. The pointed end of this course has  $1\frac{1}{4}$ -in. chisel draft each side of point. Stone blocks 3 ft. 6 in. by 4 ft. 6 in. and  $17\frac{1}{4}$  in. to  $24\frac{3}{4}$  in. thick are set on the piers to take shoes of bridge girders. They are dowelled to coping-course with  $1\frac{1}{2}$ -in. diameter iron dowels set in Portland cement.

The general details of piers are shown in the "Section of Pier 9," on accompanying plate.

The curbing is shown as cut off after the pier was completed, the dotted portion extending to grade 6 ft. above city base, being that used as a coffer-dam for half-tide work. The coffer-dam served the purpose for which they were intended, that of facilitating the depositing and levelling of the upper portion of the concrete foundation, and allowing the stonework to be laid out of water.

On many of the piers the entire foundation-course was laid while the curbing was free from water between half ebb and half flood tide.

The foundation-piles shown are those at the middle of the pier. The number of piles in a pier were 112, excepting for piers 11 and 12, where they were increased in number to 140.

The width of the concrete foundations of piers 11 and 12 was increased to 15 feet.

The foundation of draw is made of oak piles capped with hard-pine timber. The timbers supporting bottom track of draw are 18 in. by 18 in., laid in two courses upon radial timbers 18 in. by 18 in., resting on capping of piles.

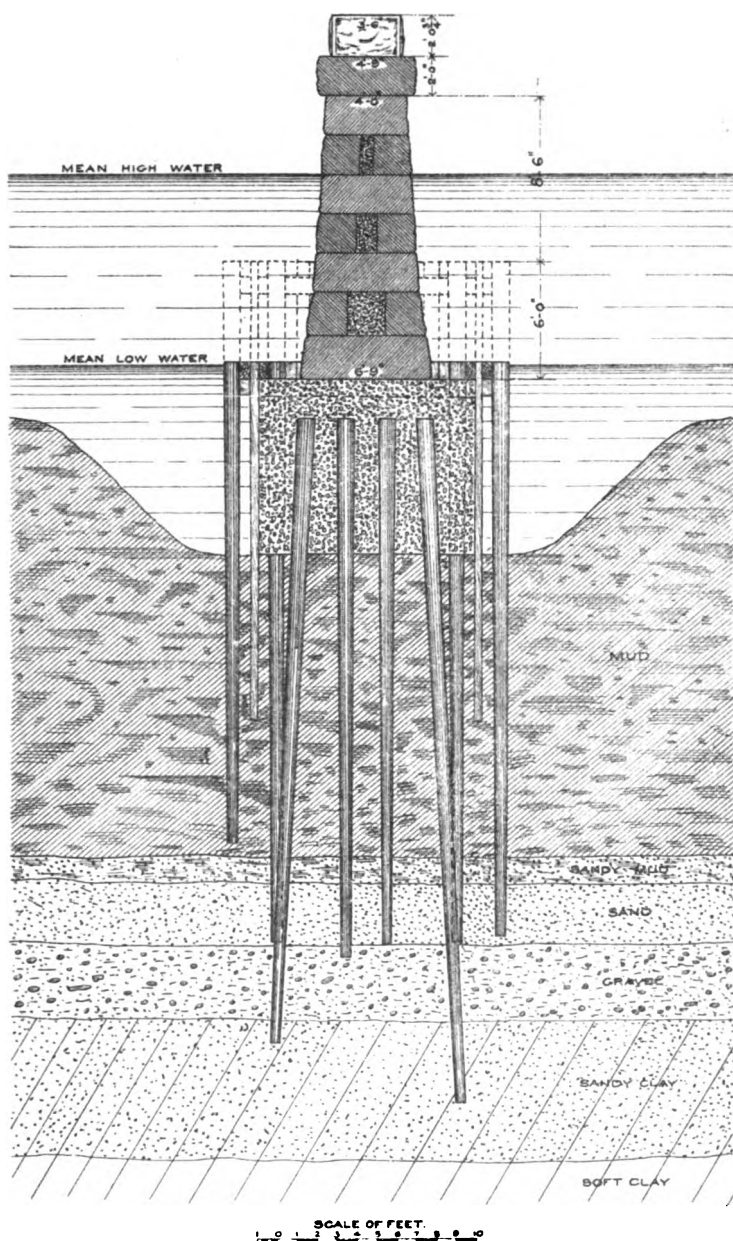
The draw-pier is 56 ft. wide and 356 ft. long, and is made of oak piles, capped and planked. The caps are hard-pine and the planking is 3-in. kyanized spruce. The faces of the pier are planked with 4-in. hard-pine, laid vertically, and fastened with  $1\frac{1}{2}$ -in. oak treenails.

Oak pile fenders, planked in same manner as faces of draw-pier, are built on channel sides of piers 11 and 12. The width of channels or waterways at draw is 36 ft. plus.

The superstructure consists of 23 fixed spans and one swing draw-span. It is of the cantilever type, the general spans being alternately 75 ft.  $2\frac{1}{2}$  in. and 105 ft.  $3\frac{1}{2}$  in. between centres of piers. The shorter spans are provided with cantilevers 15 ft.  $\frac{1}{2}$  in. long projecting beyond each

# HARVARD BRIDGE.

## SECTION OF PIER 9.





pier. From these cantilevers a span 75 ft.  $2\frac{1}{2}$  in. long is suspended, forming, with the cantilevers, the longer span of 105 ft.  $3\frac{1}{2}$  in. The end spans and those next to draw are modifications of this system. The main girders are plate girders, and are in four lines, 17 ft. 4 in. on centres. They are generally 8 ft. deep over piers and 5 ft. deep at mid span, the depth being measured from out to out of flange angle-irons. The general panel length is 15 ft.  $\frac{1}{2}$  in. The girders set upon fixed and roller shoes on the piers, connection between girders and shoes being made by pins. The suspended girders are attached to cantilevers by means of pin-and link connections, which, with the rollers on the piers, provide for expansion and contraction.

The floor-beams and sidewalk-brackets are plate girders, riveted to the main girders. The lateral bracing systems are made of rods with loop-eyes and sleeve-nuts, and struts of built section where necessary. The sway bracing is of adjustable rods or riveted angle-braces.

The fixed spans of the bridge were erected without false works. Two main girders of each span, together with the floor-beams coming between them, were riveted together, on shore, and transported to position on a scow. By taking advantage of the tide, and by arrangements for increasing or diminishing the draught of the scow, the span was easily placed upon the pier or hung in position between the cantilevers. The draw span-girders are plate girders, two in number, 8 ft. deep over turn-table, 4 ft. deep at ends, and 143 ft. 8 in. long over all. The main girders are placed 35 ft. apart on centres. Floor-beams and sidewalk-brackets are plate girders.

The main girders are connected to two heavy cross girders 6 ft. deep, which rest upon the drum of the turn-table. The turn-table drum is of wrought iron, 33 ft. in diameter and 2 ft. 6 in. deep, fitted with a planed cast-iron track. Wheels are cast iron, 21 in. in diameter, with turned treads  $7\frac{1}{2}$  in. wide. Bottom track is of cast iron, planed on both sides.

Roadway and sidewalk stringers are hard-pine, notched to floor-beams and sidewalk-brackets, to give required grade and pitch to sidewalks and roadway.

The under course of roadway plank on fixed spans is 4-in. thick kyanized spruce, and the upper course 2-in. thick spruce, excepting between the street-car tracks where it is 3 in. thick. The roadway is provided with iron scuppers for draining it. Sidewalk plank on fixed spans is  $2\frac{1}{2}$  in. thick kyanized spruce.

The wearing surface of the walks is made of asphalt, laid in the following manner: The plank having been covered

with heavy sheathing paper, a layer of gravel and pebbles, or small stone screenings, mixed with coal-tar pitch, was laid, this layer being approximately  $\frac{1}{2}$  in. thick; on this a base layer of asphalt  $\frac{3}{4}$  in. thick was placed, Barber Trinidad asphalt being used on one-half of the work and Limmer asphalt mastic being used on the other half.

The inner edges of the sidewalk are fitted with an angle-iron guard, and the outer edges are provided with a white-pine facia and galvanized-iron edging. The flooring for the draw-spans is the same as that for the fixed spans, excepting that the sidewalk is covered with 2-in. thick white-pine plank.

The railing posts are cast iron and are connected to special castings fastened to ends of sidewalk-brackets. Every other post extends above the hand-rail and carries a globe for a light. The upper or hand-rail of the railing is made of a  $3\frac{1}{2}$ -in. diameter boiler-tube and a  $1\frac{3}{4}$ -in. channel-iron; the lower rail is made of a  $2\frac{1}{2}$ -in. channel-iron, and the intermediate rail of  $1\frac{3}{4}$  in.  $\times$   $\frac{5}{8}$  in. bar iron. The vertical rods are  $\frac{3}{4}$  in. diameter.

One-half of the lamp-posts on the fixed spans, and all of those on the draw, are provided with incandescent electric lights; the balance of the lamp-posts being fitted with gas-lights.

The power for operating the draw is obtained from a 10-horse power Thomson-Houston electric-motor placed under the roadway and connected to gearing which can also be operated by hand-power. The draw is also provided with a friction-brake for controlling its motion during opening and landing. The motor and brake are operated from a point on the sidewalk of the draw.

*Table showing the Number of times the Draw was opened, and the Number of Vessels which passed through Harvard Bridge.*

1901.	No. of Openings.	No. of Vessels.
January .....		11
February .....	98	100
March .....	97	110
April .....	239	269
May .....	261	380
June .....	287	381
July .....	257	362
August .....	180	253
September .....	178	258
October .....	97	139
November .....	198	285
December .....	160	203
Totals .....	2,058	2,751

## IV. — BRIDGES SUPPORTED BY RAILROADS.

Washington-street bridge, over the Boston & Albany Railroad, has been partially rebuilt. A new roadway has been provided, and the old roadway girders are only used to carry the sidewalk.

Savin Hill avenue bridge has not yet been rebuilt, but an appropriation has been made by the city for paying the part of the cost of doing so on account of a widening of the street.

The extension of the electric car service of the West End Street Railway Co. has raised questions concerning the strength of many highway bridges maintained by railroad corporations and of the liability of the city, if any. Consequently the Corporation Counsel was requested by the City Council to advise it, and he rendered the following opinion, which is also printed in the City Council Minutes for 1891, page 1157:

CITY OF BOSTON,  
OFFICE OF THE CORPORATION COUNSEL, Nov. 21, 1891.

*To the Honorable the Board of Aldermen:*

GENTLEMEN: I am requested to give my opinion as to the powers of the Board of Aldermen as Surveyors of Highways, or County Commissioners, in regard to the matters referred to in a letter of William Jackson, City Engineer, dated Nov. 16, 1891. From reading this letter, and the proceedings of the Board on its receipt, I suppose that your honorable body wish my opinion as to whether the New York & New England Railroad Company can be compelled by the Board of Aldermen to strengthen its bridge on Broadway so as to allow electric cars to be run over it with safety. I am informed that the bridge referred to is one which by law the New York & New England Railroad Company is bound to keep in repair, and that the bridge is in good repair, and strong enough to sustain a weight of twelve or fourteen tons, but not strong enough to sustain the weight of one of the long electric cars now used by the West End Railroad Company, together with the number of passengers that are often carried on such cars.

The theory concerning highways seems to be that they are the property of the people of the Commonwealth, and are under the control of the Legislature, except where the Legislature has delegated authority to some municipality or public body. By law cities and towns are obliged to keep the highways within their limits reasonably safe and convenient, except where other provision is made.

In this case other provision has been made by the Legislature, and the city of Boston and your Board have no power in the matter. In the language of the Supreme Court in *Rouse v. Somerville*, 130 Mass., 363, "By law this bridge and approaches are to be made and kept in repair by the railroad corporation. As a matter of law and of right the city can in no mode interfere with the construction and repair of such approaches otherwise than an individual might." If the New York & New England Railroad Company does not keep its bridge in repair, an information lies in favor of the Attorney-General of the Commonwealth for its neglect so to do, and it is also liable to any traveller who is injured by reason of any defect in such bridge. But as the Legislature has provided that neither towns, cities, nor other persons bound by law to repair ways shall be liable for damages to any person whose

carriage and the load thereon exceed the weight of six tons, I do not think the New York & New England Railroad Company can be compelled by any process of law to strengthen its bridge so as to bear the weight of vehicles which, with their loads, sometimes weigh nearly twenty tons. If a part of the highway is strong enough to sustain the weight of a vehicle weighing more than twice the weight limited by the statutes, I have no doubt that it is reasonably safe and convenient in the meaning of the statute. If your honorable body is informed, or has reason to believe, that any portion of a highway is not strong enough to support the weight of the electric cars in use by the West End Road, and is strong enough to fulfil the statute requirements, your Board ought not to permit the use of such heavy cars upon such highway until the street-railway company has so strengthened such portion of the highway as to make it possible to operate such cars without danger to life.

Respectfully submitted,

(Signed) THOMAS M. BABSON,  
*Corporation Counsel.*

The bridges over the New York & New England Railroad, on Norfolk street, referred to in last year's report, have been slightly repaired. They are poor bridges.

The other bridges in the list of bridges supported are strong enough for ordinary travel, and require no special mention.

## MISCELLANEOUS WORK AND CONSTRUCTION IN 1891.

### BENNINGTON-STREET CULVERT.

See page 90.

### BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

See page 90.

### CURBING FOR PUBLIC SQUARES IN EAST BOSTON.

At the request of the Superintendent of Public Grounds, plans and specifications were prepared for granite curbings around Belmont, Central, and Maverick squares, East Boston.

The curbing at Belmont square was furnished by J. Harrington & Son, Somerville, at a cost of \$2,998; that at Central square by Austin Ford, Cambridge, at a cost of \$3,165, and that at Maverick square by B. F. Nay & Co., at a cost of \$1,533.20.

### CHELSEA-BRIDGE STEAM POWER.

See page 91.

**CHELSEA BRIDGE (NORTH) FENDER-GUARD.**

See page 91.

**CORNWALL-STREET BRIDGE.**

See page 91.

**EAST BOSTON BRIDGE.**

In compliance with the following order of the City Council, approved by the Mayor, Sept. 19, 1891,

"That the City Engineer communicate with citizens of East Boston, and, in consultation with them, prepare plans for a bridge to East Boston, and take such measures as he deems proper to assist the Board of Harbor and Land Commissioners in their inquiry as to the expediency of constructing a bridge to East Boston," a plan was devised for a bridge to East Boston.

The proposed bridge was located near the North ferry, and, with its approaches, was about 2,300 feet long, the channel at this point being about 1,450 feet between bulk-head lines. The proposed bridge was an iron structure, supported on piers; it was 80 feet in width with a swing draw 60 feet wide, having two drawways, 100 feet wide, for vessels, the vessel drawways to have a clear height under the draw of 35 feet at mean high water. The roadway of the bridge was to be of granite-block pavement, excepting on the draw, where it was to be of wood.

**FEDERAL-STREET BRIDGE.**

As mentioned in the last annual report, the rebuilding of every part of this bridge, except the two draws, was let to Shaw & Miller, by contract, dated July 23, 1890, for \$67,467.

The bridge was rebuilt, one-half at a time, without interruption to travel. The up-stream half of the bridge was closed to travel July 29, 1890; opened to travel Feb. 14, 1891; the down-stream half was closed to travel Feb. 16, and opened Aug. 12, 1891. The up-stream half was again closed Aug. 18, 1891, and the whole bridge was opened to travel Sept. 12, 1891, and the whole work on Shaw & Miller's contract was completed Oct. 16, 1891.

The bridge is 69 feet wide between fences and is built of hard-pine lumber on an oak-pile foundation. There are two sidewalks, each 10 feet wide, covered with asphalt, on a base of coal-tar concrete. The roadway is 49 feet wide, except at the draws, where it is divided into two roadways, each 21 feet in width.



The roadway is covered with 6-inch kyanized spruce lumber; on this is a layer of fine coal-tar concrete, three inches thick, heavily rolled while hot; above this is a granite-block paving laid in a bed of sand, having the joints filled with small pebbles and run with hot paving-cement.

The down-stream pier has been lengthened 58 feet; the drawway has been widened from 36 feet to 41 feet 10 inches, and is now planked with vertical planks extending 2 feet below low water.

The iron draws in the bridge are two in number, and are of the retractile pattern. The channel span of each draw are placed side by side, the draws being drawn to opposite sides of the channel when opened.

Each draw is 32 feet 9 inches wide between centres of main girders, and carries a roadway 21 feet wide in the clear, and a sidewalk 10 feet 3 inches wide from curb to centre of railing.

Each draw is composed of two non-continuous plate girder spans, one of which spans the channel through the bridge, the other, or rear span, being supported on trucks running on tracks built on the draw foundation.

When a draw is closed, and in position for travel over it, the channel span is supported at its front end on shoe-plates on the main bridge, the other end being attached to and supported by the rear span by a pin connection. When the draw is in motion or run off, the front end of the channel span is supported by suspension rods passing over Samson posts on rear span to back end of this span, proper counter-balances being provided where necessary. The counter-balance used on these draws are cast-iron boxes filled with lead.

The motive power for the draws is electricity, in addition to which gearing, etc., is provided for operating them by hand or horse power in case of accident to the electric plant.

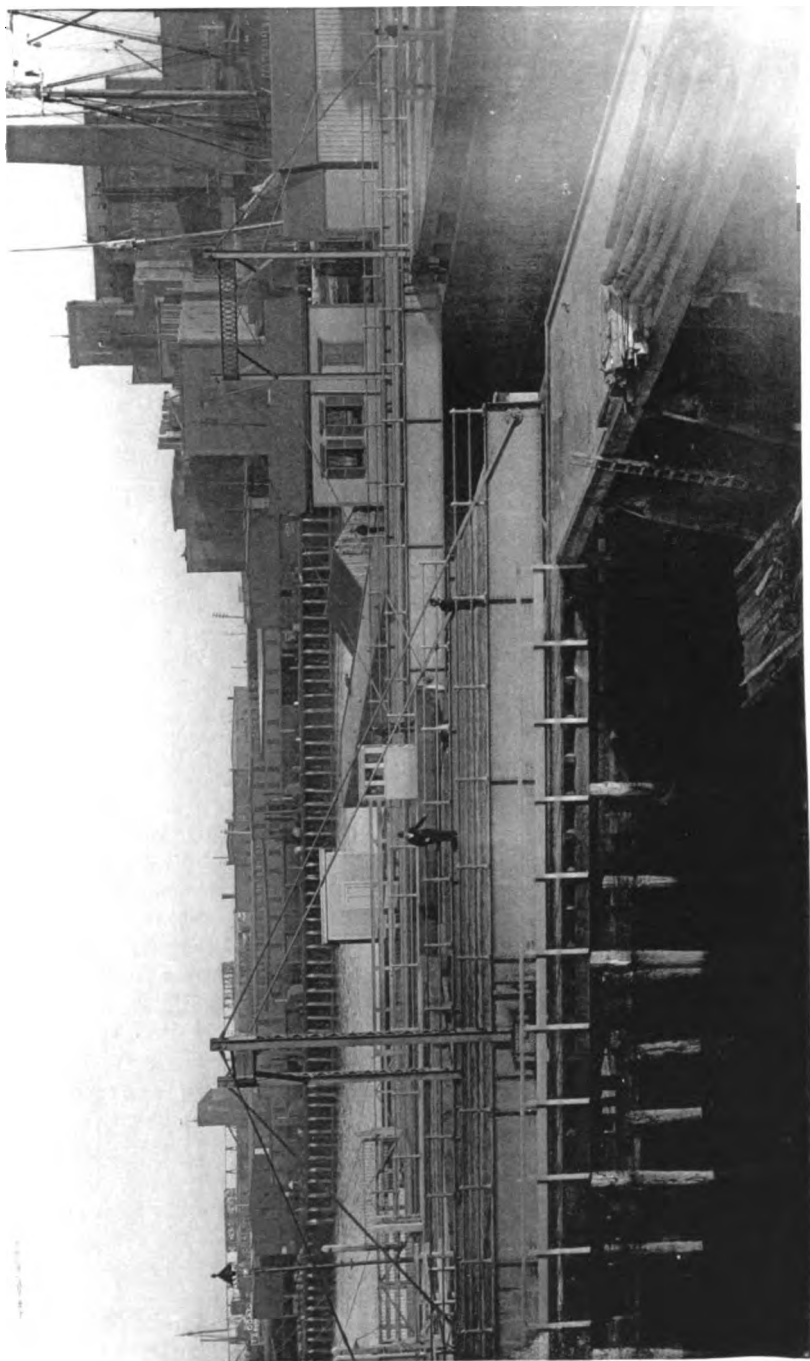
Each draw is moved by a 20-horse power Thomson-Houston motor, connected by shafting to a horizontal drum under the draw, from which drum motion is transmitted to the draw by a wire rope. The general arrangement of drums, etc., is similar to that for the draws at Warren bridge.

The draws are operated and controlled by one man, from a small house situated near the channel, on the Boston side. Thus far the electric power has worked satisfactorily.

The draws and the machinery for operating them were designed by this department.

The contractors for the pile bridge were Shaw & Miller, of Boston.

The draws were built by the Pittsburgh Bridge Co., and



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FEDERAL STREET DRAWBRIDGE, 1891.





—HELIOTYPE PRINTING CO., BOSTON

FEDERAL STREET DRAWBRIDGE, 1891.



the machinery by the Whittier Machine Co., of Boston, and Miller & Shaw, Cambridge.

The electric plant was furnished by the Thomson-Houston Motor Co., Boston.

The total expenditure for the work to Feb. 1 was \$99,285.17.

#### FERDINAND-STREET BRIDGE (OVER THE BOSTON & ALBANY RAILROAD).

In July, 1890, this bridge was closed by order of the Mayor, an examination made by this department having shown that it was unsafe to permit its further use. An appropriation of \$35,000 for rebuilding the bridge was made by the City Council and approved by the Mayor, Nov. 12, 1890. Plans and specifications were at once prepared and the work advertised Dec. 10, 1890.

The plan of rebuilding provided for filling solid the portion of the street, north of the railroad track, supported by iron posts, and for building a retaining-wall on the westerly line of the street, about 73 feet long, to hold this filling and to supersede an old timber bulkhead. The only portion remaining to be bridged was that over the track of the Boston & Albany Railroad.

The bridge is a single span of two through-plate girders, 79 feet long, and is 40 feet wide between centres of railings, affording a clear roadway of 22 feet, and two overhanging sidewalks of 7 feet 6 inches each. The two main girders are 6 feet 6 inches deep at the centre, and 5 feet 6 inches deep at the ends, and were designed so that in case the bridge should be widened to 50 feet it would be only necessary to add one new girder and one set of floor-beams, as illustrated in last year's report. The floor-beams and sidewalk brackets are built iron beams and the stringers are of hard-pine. The roadway planking is of spruce, under course 4 inches thick and upper course 2 inches thick. The sidewalk planking is 2 inches hard-pine. The fences are 6 feet high, made of matched white-pine boards. New granite parapets were laid on both abutments, and the coping on the south-east retaining-wall was relaid and brought to the new grade of the street.

As it was desirable to complete the work of rebuilding as speedily as possible, it was deemed best to build the retaining-wall of concrete. The wall as built is supported on a spruce pile foundation with a cap of Portland cement concrete, 4 feet thick and varying in width from 13 feet at the highest part of the wall to 11 feet at the low end. The

body of the wall is built of cement concrete made in the proportions of one part of cement, two parts of sand, and five parts of broken stones, deposited in layers of 8 inches in thickness and thoroughly rammed. With the exception of an upper course, 12 inches thick, the cement used was American hydraulic of approved brand. Portland cement was used for the upper 12-inch course. Extending from the foundation to the coping, a brick facing, 8 inches thick, was built in front of the wall, laid solid in Portland cement mortar and thoroughly bonded to it. Along the entire length of the wall a granite coping, 30 inches wide and 18 inches thick, was laid, and on this was placed a close board fence, 6 feet high, supported by iron standards.

The contractor for the retaining-wall and parapets was R. D. Shanahan, of Portland, Me.; total amount paid, \$4,869.23. The contractor for the superstructure was the R. F. Hawkins Iron Works, Springfield, Mass.; amount paid, \$4,096.45. The total amount expended by this department from the appropriation, including engineering and inspection, was \$9,734.36.

#### FERRY DEPARTMENT.

The building of a part of the ferry-slip at East Boston, North ferry, by J. N. Hayes & Co., mentioned in the last annual report, was completed Feb. 14, 1891, and the cost of the contract work was \$7,480.

An interesting feature of this work was the successful driving of twenty-five very large oak piles, with the small end upward, reversing the usual method. The work of driving these piles was done without difficulty. As these piles are not required to sustain weight, but to resist sidewise thrusts and blows, applied from twenty to thirty feet above hard bottom, they are found to be much more efficient than if driven in the usual way.

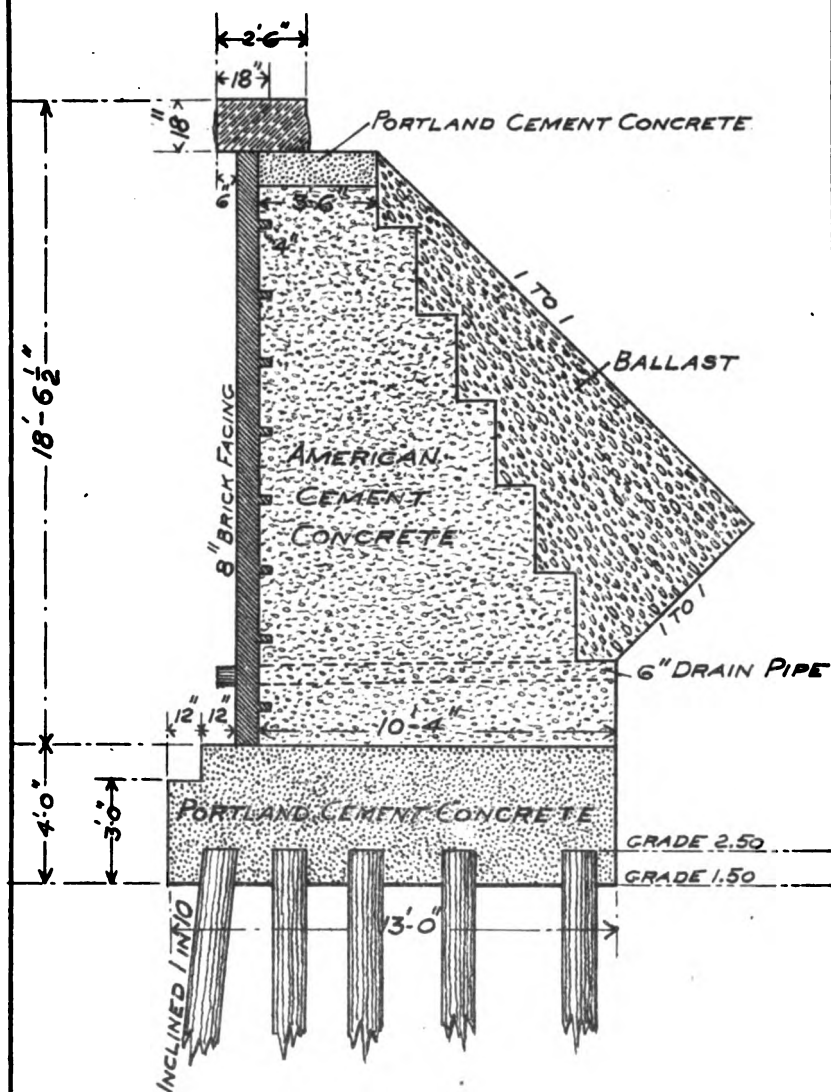
Estimates, detailed plans, specifications, and contract for building a foundation for head-house and rebuilding part of two ferry-piers at the East Boston landing of the North ferry have been furnished, and the contract for doing the work was awarded to Nay & Ellis, for \$9,456. Work was begun Oct. 24 and continued to Dec. 31. Work cannot be resumed until the head-house now being built is ready for occupancy. The payments on account of the contract to Feb. 1, 1892, have been \$3,219.80.

Plans, estimates, and specifications were made for building a wharf adjoining the new head-house; the contract for doing the work, with the exception of the planking, which was done

# FERDINAND STREET BRIDGE.

## SECTION OF RETAINING WALL.

—1891.—







by the Ferry Department, was awarded to Nay & Ellis, and completed Jan. 18, 1892, at a cost of \$1,665.

Soundings have been taken and plans made showing depth of water in all of the ferry-slips, except at the East Boston side of the North ferry.

All of the above work has been done under the superintendence of this department.

#### HILL-STREET RETAINING-WALL.

See page 92.

#### IRVINGTON-STREET FOOT-BRIDGE (OVER PROVIDENCE DIVISION, OLD COLONY RAILROAD).

See page 92.

#### IRVINGTON-STREET AND YARMOUTH-STREET RETAINING-WALLS.

See page 92.

#### L-STREET ABUTMENT.

See page 93.

#### L-STREET BRIDGE.

The Legislature, at its session of 1891, passed the following act :

[CHAP. 388.]

AN ACT TO PROVIDE A PUBLIC HIGHWAY BRIDGE ACROSS THE RESERVED CHANNEL AT SOUTH BOSTON.

*Be it enacted, etc., as follows :*

SECTION 1. The city of Boston is hereby authorized and required to build and maintain a public highway bridge across the reserved channel on the South Boston flats in said city, connecting Eastern avenue or Congress street, so called, as laid out and graded by the Commonwealth, with L street extended to the southerly line of said channel. Said bridge shall be constructed in accordance with plans prescribed or approved by the Board of Harbor and Land Commissioners. Upon the completion of said bridge, provided the same is completed before the first day of August in the year eighteen hundred and ninety-two, forty per cent. of the cost thereof shall be reimbursed by the Commonwealth to said city out of the Commonwealth's flats improvement fund established by chapter two hundred and thirty-seven of the acts of the year eighteen hundred and seventy-eight.

SECTION 2. This act shall take effect upon its passage.

[Approved June 9, 1891.]

Plans and specifications were prepared which received the approval of the Board of Harbor and Land Commissioners, Oct. 29, 1891. The work was advertised on Dec. 14, 1891,

soliciting proposals for the completion of the work at different dates; namely, July 15, 1892, and Dec. 1, 1892. The contract for the work has not been awarded at this date, pending action of the Legislature on a petition of His Honor the Mayor for an extension of the time for completing the work from Aug. 1 to Dec. 1, 1892.

#### L-STREET BULKHEAD.

See page 93.

#### NORTH HARVARD-STREET AND ESSEX-STREET BRIDGES, BRIGHTON TO CAMBRIDGE.

These bridges have been partly rebuilt for the purpose of providing them with draw channels 36 feet in width.

The work was done under the direction of the City Engineer of Boston, the City of Cambridge paying one-half the cost.

The work on North Harvard-street bridge was described in the last report, and was completed Feb. 9, 1891.

Essex-street bridge was opened to travel March 21, and was completed May 1, 1891.

#### PUBLIC INSTITUTIONS.

Special examination of the wharves at Deer, Long, and Rainsford islands was made at the request of the commissioners, and a report submitted to them.

#### ROXBURY-CANAL SEA-WALL.

See page 93.

#### SAVIN HILL AVENUE BRIDGE (OVER OLD COLONY RAIL- ROAD).

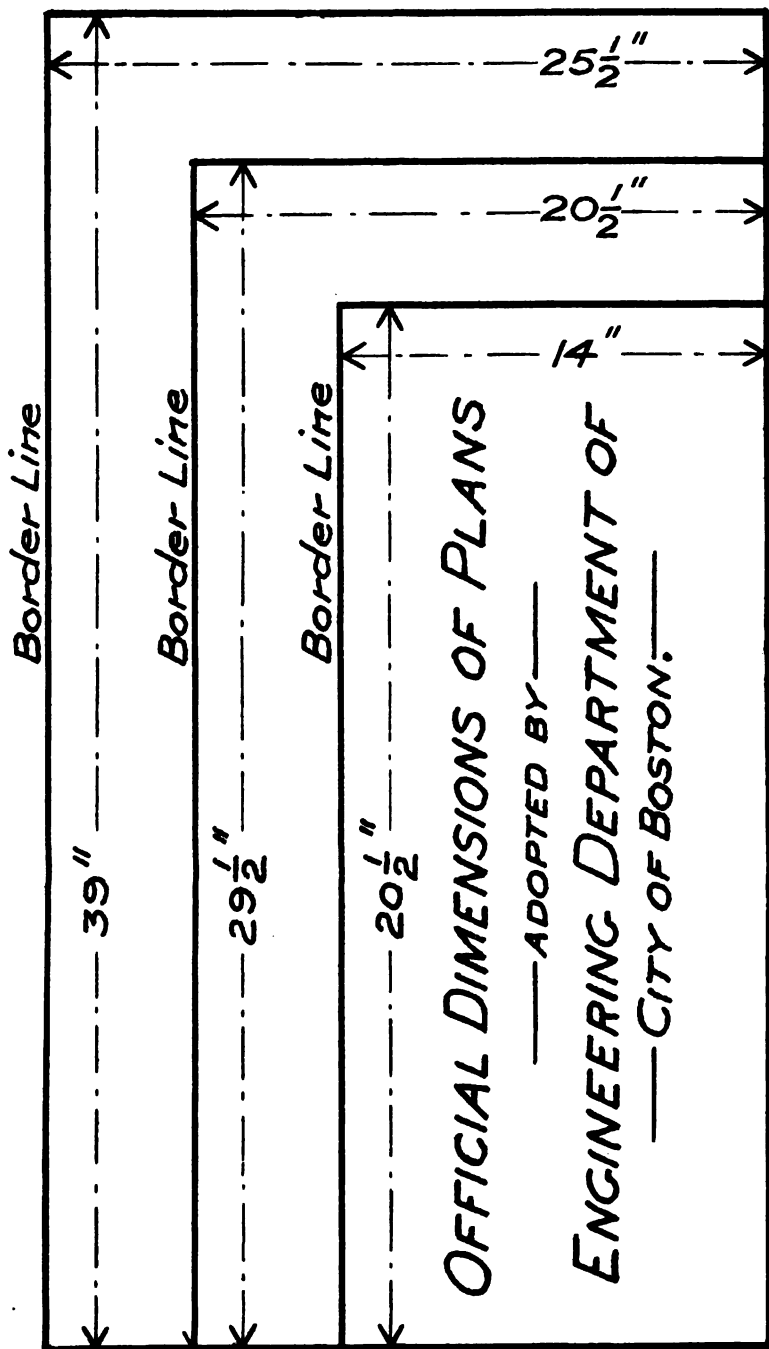
Plans for building a new bridge on Savin Hill avenue have been submitted by the Old Colony Railroad, and an agreement made with the railroad company for doing the work, the city to pay \$5,000 of the cost thereof.

#### STONY-BROOK IMPROVEMENT (ROSLINDALE BRANCHES).

See page 93.

#### WALKS IN PUBLIC GROUNDS.

Plans and specifications were made for concrete walks on the Common, from West-street entrance to Park-street steps,





the work being done by Simpson Bros., at a cost of \$2,691.

Plans and specifications were also made for paving Montgomery square, walks on Blackstone square, and walk on the Common, from Tremont street, opposite Winter street to Beacon street, opposite Spruce street, with Hastings asphalt tiles.

The work was done by John Turner & Co., and cost as follows: Montgomery square, \$814.00; Blackstone square, \$3,900.00; and walk on Common, \$3,676.40.

The above work was done under the supervision of this department.

#### SPECIAL EXAMINATION OF BRIDGES.

Special examination of Broadway bridge, over New York & New England Railroad; Broadway bridge, over Fort Point Channel; Winthrop bridge, and Washington-street bridge, over New York & New England Railroad, were made to ascertain their strength under electric-railroad traffic.

Other work of a miscellaneous character was principally as follows:

#### PLANS AND ESTIMATES.

For abolition of grade crossings at Washington street, Forest Hills, and at Cambridge street, Allston.

For elevating Chelsea bridge over the tracks of the Boston & Maine Railroad.

For tunnel for foot traffic at Franklin street, Allston.

For temporary bridge to Castle Island, and draw for same.

For a bridge to East Boston.

#### ESTIMATES.

For a bridge for New York & New England Railroad, at Geneva avenue.

For filling on Ninth street, between G and H streets.

For a retaining-wall at corner of G and Ninth streets.

For rebuilding Western-avenue bridge to Watertown.

For rebuilding North Beacon street bridge to Watertown.

A large amount of miscellaneous office-work has also been done, such as making record plans, maps for Water and Park departments, and copying, tracing, and blue-printing plans.

#### IN GENERAL.

About May 1, Assistant Engineer Henry Manley was assigned to the immediate direction of the several paving

contracts for the Street Department, and the work in progress of construction, which was in his charge, was assumed by Assistant City Engineer John E. Cheney in addition to his other duties.

#### RAPID TRANSIT.

By act of the Legislature for the year 1891, the City Engineer was made *ex officio* a member of the Rapid Transit Commission, and much time has been devoted to that commission.

**B.**

[FROM THE CITY ENGINEER'S REPORT TO THE BOSTON  
WATER BOARD.]

**SOURCES OF SUPPLY.**

The rainfall upon the water-sheds during the past year varied but little from the average amount, but less than the usual proportion fell during the summer and fall months, consequently the storage in the reservoirs began to be reduced in June and July, and steadily decreased until the latter part of December.

The rainfall and quantities collected on the several water-sheds were as follows :

	Sudbury.	Cochituate.	Mystic.
Rainfall in inches .	49.52	46.42	47.40
Rainfall collected, inches . . . .	27.612	32.07	28.60
Daily average yield of water - shed, gallons . . .	98,900,000	28,800,000	36,600,000

The quality of the water from all the supplies has been comparatively good.

The fluctuations in the amounts of water in the different lakes and reservoirs are shown graphically by an appended diagram.

The condition of the different reservoirs during the year is given below :

*Reservoir No. 1.* — Water was wasting at the dam from January 1 to July 2, with the exception of five days in May, after the stop-planks were placed on the dam, and during five days in June. No water wasted over the dam after July 2, and only the one and one-half million gallons per day was allowed to flow through the waste-gates, as required by law.

The dam is in good condition.



*Reservoir No. 2.* — Water was flowing over the dam or through the gates of Dam 2 until May 9, when the flash-boards were placed in position. The reservoir filled to the top of the flash-boards four days later, but water was drawn from this reservoir to supply the city on the 14th, and the surface immediately fell below the top of the flash-board, and the reservoir did not fill again during the year. The lowest point reached was on August 19, when the surface was 9.48 feet below the top of the flash-boards.

The dam at Reservoir 2 is in good condition.

*Reservoir No. 3.* — This reservoir was full until the middle of August, except during February and March, when it was drawn down in anticipation of the usual large spring flow. On August 19 this reservoir was drawn from to supply the city, and its surface gradually fell until November 24, when it was at grade 162.32, or 12.92 feet below the crest of the overflow.

On Jan. 1, 1892, it had risen to 167.19, or 8.05 feet below the crest.

The dam at Reservoir 3 is in good condition.

*Reservoir No. 4.* — This reservoir was kept full until July 15, with the exception that it was lowered as usual in the spring.

On July 15 the outlet gate was partially opened to furnish a portion of the city's supply, and the reservoir gradually fell until September 26, when the gate was closed. The height at that date was 202.91, or 12.30 feet below the top of the flash-boards. Since that date no water has been drawn from the reservoir, and its surface has gradually risen. On January 1 its height was 207.85, or 6.36 feet below the crest of the dam.

The dam of Reservoir No. 4 is in good condition.

*Farm Pond.* — The surface of the pond has been kept at an average height of 149.12.

The conduit through the pond has been in use all the year, no water having been drawn from the pond to supply the city.

The Framingham Water Company has pumped 80,500,000 gallons from the pond, an average of 220,500 gallons per day.

*Lake Cochituate.* — Water was wasted from the outlet dam from January 2 to 7, and from January 12 to April 25.

The surface of the lake began to fall on April 26, and continued to fall slowly and with great regularity until

November 26, when it was at grade 126.44, or 7.92 feet below high-water, the lowest point during the year.

The lake began to fill during the latter part of December, and on January 1 it had risen to grade 127.34, or 7.02 feet below high-water line.

The heights of water in the various storage reservoirs on the first day of each month are given below :

	RESERVOIRS.				FARM POND.	LAKE COCHITU- ATE.
	No. 1.	No. 2.	No. 3.	No. 4.		
	Top of Flash- boards. 159.29	Top of Flash- boards. 167.12	Crest of Dam. 175.24	Top of Flash- boards. 215.21	High- Water. 149.25	Top of Flash- boards. 134.36
January 1, 1891 . . . . .	157.66	165.96	175.32	214.41	149.36	132.49
February 1, " . . . . .	158.23	166.13	175.36	210.11	149.17	133.14
March 1, " . . . . .	158.27	166.20	175.45	210.77	149.90	132.75
April 1, " . . . . .	158.07	166.27	175.42	211.97	148.97	134.14
May 1, " . . . . .	157.77	166.00	175.34	214.53	149.39	134.12
June 1, " . . . . .	159.37	166.10	175.41	214.74	149.26	133.20
July 1, " . . . . .	159.37	165.37	175.36	214.81	149.09	132.23
August 1, " . . . . .	157.68	160.36	175.31	211.56	148.89	130.71
September 1, " . . . . .	157.89	159.33	174.03	206.21	148.93	129.43
October 1, " . . . . .	157.59	158.93	172.13	202.91	148.79	128.30
November 1, " . . . . .	157.25	159.08	167.70	203.97	148.81	127.06
December 1, " . . . . .	157.00	160.30	163.50	205.46	148.80	126.69
January 1, 1892 . . . . .	157.20	163.55	167.19	207.85	148.99	127.34

Water has been drawn from the different reservoirs as follows :

#### RESERVOIR No. 1.

July 3 to 6, inclusive.

#### RESERVOIRS NOS. 1 AND 2.

July 2.

#### RESERVOIR No. 2.

May 17 to 24.

May 28 to June 7.

June 9 to 10.

June 16 to 18.

June 30 to July 1.

July 7 to Aug. 18.

Sept. 15 to 24.

Dec. 20 to 31.

## RESERVOIRS NOS. 2 AND 3.

Jan. 1 to 4.	April 8 to 11.
Jan. 7 to 11.	April 16 to 18.
Jan. 15 to 18.	April 20 to 26.
Jan. 22 to 26.	April 30 to May 3.
Jan. 29 to Feb. 1.	May 7 to 9.
Feb. 5 to 8.	May 14 to 16.
Feb. 12 to 15.	May 25 to 27.
Feb. 19 to 23.	June 11 to 14.
Feb. 27 to March 1.	Aug. 19 to Sept. 14.
March 5 to 8.	Sept. 25 to Oct. 26.
March 12 to 15.	Oct. 28 to Nov. 16.
March 19 to 22.	Nov. 19 to 29.
March 26 to 28.	Dec. 1 to 19.
April 1 to 4.	

## AQUEDUCTS AND DISTRIBUTING RESERVOIRS.

The Sudbury-river conduit has been used 298 days, and the Cochituate has been used 352 days. The Sudbury conduit has delivered 8,306,600,000 gallons into Chestnut-hill and Brookline reservoirs, equal to a daily supply of 22,760,000 gallons; the Cochituate aqueduct has delivered 5,508,180,000 gallons, or 15,091,000 gallons per day.

In the Cochituate aqueduct a nearly uniform depth of six and one-half feet was maintained until the middle of October, when the surface of the lake had fallen so low that this depth could not be maintained.

During the balance of the year the depth in the aqueduct closely followed the depth in the lake above the bottom of the aqueduct, and at one time it was only five feet four inches.

The rate of flow in the Sudbury conduit was varied almost daily to maintain the desired height in the distributing reservoirs. Both conduits were cleaned as usual during the year.

On April 19 one of the 40-inch siphon-pipes of the Cochituate aqueduct at Newton Lower Falls was split by the weight of gravel-filling that had been deposited over the pipes in building a new street across the location of the siphon. The water was shut off and the split pipe replaced before any damage had been done.

The Chestnut-hill, Brookline, Fisher-hill, Parker-hill, and East Boston reservoirs, and the Breed's Island water-tower, are in good condition. I recommend that the elm-trees at the base of the Chestnut-hill reservoir dam be removed. The inside of the iron water-tower on Bellevue hill should be painted this year.

The South Boston reservoir has not been in daily use for many years, but is kept partially full of water for use in special emergencies, and for this reason is still of value to the water-supply service. A check-valve should be placed in the high-service connection with this reservoir, to automatically supply the fire-hydrants within the high-service district of South Boston in case of serious fires.

#### HIGH-SERVICE PUMPING-STATIONS.

At Chestnut hill the pumping-engines and boilers are in excellent condition.

A permanent apparatus for weighing the feed-water has been placed in the boiler-room, and the accuracy of the feed-water meters is now easily ascertained from time to time, so that corrections can be made in calculating the efficiency of the boilers.

The table on page 62 shows in detail the work done by the pumping-engines and boilers during the year.

Engine No. 1 was used	3,419½	
hours, pumping	.	1,264,475,610 gallons.
Engine No. 2 was used	3,768½	
hours, pumping	.	1,386,688,800 "
Total amount pumped	.	2,651,164,410 "
Total amount coal consumed	.	2,910,751 pounds.
Percentage ashes and clinkers	.	8.5
Average lift in feet	.	124.6
Quantity pumped per lb. of coal	.	910.8 gallons.
Daily average amount pumped	.	7,263,500 "

The amount pumped is an increase of 11.9 per cent. over that of 1890.

The same boiler supplied steam for pumping, and for heating and lighting the pumping-station and other buildings near the station.

#### COST OF PUMPING.

Salaries	.	.	.	.	.	.	.	\$9,590 40
Fuel	.	.	.	.	.	.	.	6,558 28
Repairs	.	.	.	.	.	.	.	701 93
Oil, waste, and packing	.	.	.	.	.	.	.	534 51
Small supplies	.	.	.	.	.	.	.	257 18
Total	.	.	.	.	.	.	.	<hr/> \$17,642 30

Cost per million gallons raised one foot high	.	\$0.053
Cost per million gallons pumped to reservoir	.	6.65

At the West Roxbury pumping-station 24,108,000 gallons have been pumped, equivalent to a daily average of 66,000 gallons, — an increase of 68.4 per cent. over that pumped in 1890.

At the East Boston pumping-station an average of 13,500 gallons per day has been pumped into the Breed's Island water-tower.

Water was pumped into the East Boston reservoir only on two days in January, one day in February, and two days in March, as the reservoir could be filled during the night from the low-service mains during the balance of the year.

#### MYSTIC LAKE.

Water was wasted over the dam almost constantly until June 9, and again from June 22 to June 28. From this date the surface of the lake gradually fell until it was 7.67 feet below high-water on November 26, or only 3.50 feet above the bottom of the conduit. This was only about 4 inches above the point where the supply for the pumping-station could not be maintained by gravity.

Early in October the centrifugal pumps were placed in position at the lake to raise the water into the conduit, but fortunately it was not necessary to use them.

Advantage was taken of the low stage of the water to repoint the masonry at the overflow.

On January 1, 1892, the water in the lake had risen to grade 2.32, or 4.68 feet below high-water, and water was wasting over the dam on January 15.

The table on page 60 shows the yield of the water-shed. The rainfall there recorded is an average from two gauges, one located at the lake and one in Winchester.

The record of the latter gauge was kept by Mr. L. R. Symmes, formerly assistant superintendent, gratuitously until his death, last February. Since his death the gauge has been maintained and records kept by Miss A. F. Symmes.

#### MYSTIC VALLEY SEWER.

The pump was run 356 days during the year of 1891, working 6,391½ hours, and has pumped 119,404,000 gallons of sewage, or an average of 335,400 gallons per day of pumping. The amount pumped is only one-fourth of one per cent. greater than in 1890.

The total amount of sulphate of alumina used during the

year was 303,780 pounds, and 173 tons of coal were used in pumping.

#### MYSTIC CONDUIT AND RESERVOIR.

The conduit was cleaned twice during the year, and is in good condition.

New sills and grooves for the screens should be placed in the screen-chamber, and the roof of the chamber should be raised to facilitate the changing of the screens. A new gate should be placed on the blow-off pipe, to exclude the tide-water.

The reservoir has not been cleaned for several years, otherwise it is in good condition.

#### MYSTIC PUMPING-STATION.

The pumps have received quite extensive repairs, and are in good condition.

The three older boilers should have new fronts, to correspond with those on the new boilers; a sluice-gate should be placed in the pump-well of Engine No. 3, as under the present condition any accident to the foot-valve of this pump would necessitate the stopping of the whole plant. A duplicate dynamo for lighting the building should be procured, and it would be an economical measure to build a new chimney of larger capacity if the plant is to be continued in service.

The table on page 63 shows in detail the work done by the pumping-engines during the year.

Engine No. 1 was in use 884	
hours, pumping . . . . .	145,186,500 gallons.
Engine No. 2 was in use 1,774 $\frac{1}{4}$	
hours, pumping . . . . .	346,862,000 "
Engine No. 3 was in use 8,352 $\frac{1}{2}$	
hours, pumping . . . . .	2,812,902,400 "
Total amount pumped . . . . .	3,304,951,000 "
Total amount coal consumed . . . . .	6,988,500 pounds.
Percentage ashes and clinkers . . . . .	10.2
Average lift in feet . . . . .	148.02
Quantity pumped per lb. of coal . . . . .	472.9 gallons.
Average duty of engine per 100	
lbs. of coal, no deductions . . . . .	58,380,500 ft.-lbs.
Daily average amount pumped . . . . .	9,054,700 gallons.

The amount pumped is an increase of 9.1 per cent. over that of 1890.

### COST OF PUMPING.

Salaries . . . . .	\$9,628 07
Fuel . . . . .	13,946 42
Repairs . . . . .	954 69
Oil, waste, and packing . . . . .	983 96
Small supplies . . . . .	444 89
<b>Total . . . . .</b>	<b>\$25,958 03</b>

Cost per million gallons raised one foot high .	\$0.053
Cost per million gallons pumped to reservoir .	7.85

### CONSUMPTION.

The daily average consumption from the combined works, and the consumption, compared with that of 1890, was as follows :

	COCHITUATE WORKS.		MYSTIC WORKS.		COMBINED SUPPLIES.	
	Consumption in Gallons.	Percentage of Consumption of 1890.	Consumption in Gallons.	Percentage of Consumption of 1890.	Consumption in Gallons.	Percentage of Consumption of 1890.
January . . . . .	87,230,100	110.5	9,389,300	114.7	46,619,400	111.3
February . . . . .	87,280,700	112.9	9,466,900	114.1	46,747,600	113.1
March . . . . .	86,538,400	115.2	8,811,000	109.4	44,344,400	114.0
April . . . . .	86,761,600	117.3	8,048,800	107.5	43,797,400	115.4
May . . . . .	86,580,700	116.6	8,841,300	118.1	45,421,900	113.9
June . . . . .	87,801,900	114.5	9,478,400	112.9	47,280,300	114.3
July . . . . .	89,062,500	106.4	9,581,700	101.3	48,644,200	106.4
August . . . . .	89,460,400	108.7	9,123,300	102.1	48,582,800	107.4
September . . . . .	40,677,700	112.5	9,128,700	108.2	49,806,400	111.7
October . . . . .	88,845,600	116.3	9,259,100	118.9	48,104,800	116.3
November . . . . .	86,640,800	111.2	8,585,200	112.9	45,226,000	111.5
December . . . . .	87,842,500	97.4	8,960,600	94.6	46,303,10 0	96.9
<b>Average . . . . .</b>	<b>87,686,900</b>	<b>111.3</b>	<b>9,065,200</b>	<b>109.1</b>	<b>46,742,100</b>	<b>110.8</b>

The daily average consumption per head of population was as follows :

Sudbury and Cochituate supply,	89.3 gallons.
Mystic supply . . . . .	74.7 “
Combined supplies . . . . .	86.0 “

The above figures show an increase of 11.3 per cent. in the consumption supplied from the Sudbury and Cochituate works from that of the previous year ; of 9.1 per cent. in the consumption supplied from the Mystic works ; and of 10.8 per cent. increase in the consumption supplied by the combined supplies.

#### DEACON METERS.

There are now in use 81 meters, — 74 on the Cochituate system and 7 on the Mystic system, — and the territory covered by the meters is divided into 176 sections ; 8 sections were not tested during the past year.

The quantity supplied to the entire residential portion of Boston can now be tested by the meters, excepting a portion of West Roxbury and that portion of the Back Bay district bounded by Boylston street, Parker street, and the Boston & Providence Railroad.

During the coming year two meters should be placed in the latter territory ; but the West Roxbury district cannot be advantageously tested until the district is more densely populated.

On the Mystic system Charlestown is practically covered by meters ; one meter covers a small portion of Somerville, and one about one-quarter of Chelsea. Everett has no meters.

The estimated population supplied with water, and the population that is covered by Deacon meters in the different sections of the city, is as follows :

SECTION.	Estimated Population.	Population on Meters.
City proper . . . . .	164,875	132,000
Roxbury . . . . .	104,000	84,000
West Roxbury . . . . .	28,510	14,300
Dorchester . . . . .	34,025	27,500
Brighton . . . . .	13,700	5,400
South Boston . . . . .	76,535	65,000
East Boston . . . . .	41,375	32,000
Charlestown . . . . .	45,930	32,500
Chelsea . . . . .	33,775	9,300
Somerville . . . . .	46,675	4,400



The consolidated results of the readings of the various sections is shown in the following table, in which is given the final reading of 1890, the first and last readings of this year, the differences between the first and second readings of this year, and the differences between the last readings of this year and those of 1890.

#### Cochituate System.

SECTION.	Population.	1890. 2d Reading.		1891. 1st Reading.		1891. 2d Reading.	
		Daily con.	Night rate.	Daily con.	Night rate.	Daily con.	Night rate.
City proper . . . . .	132,000	52.5	29.4	56.9	35.3	61.7	37.5
Roxbury . . . . .	84,000	49.2	28.8	58.1	36.4	53.5	36.8
West Roxbury . . . . .	14,800	53.8	23.1	50.6	23.1	. . . . .	. . . . .
Dorchester . . . . .	27,500	49.0	25.8	52.8	25.2	49.9	27.7
Brighton . . . . .	5,400	52.1	24.0	61.3	27.1	. . . . .	. . . . .
South Boston . . . . .	66,000	40.5	24.0	41.3	25.6	47.3	26.6
East Boston . . . . .	32,000	34.5	20.2	35.7	24.2	39.9	25.6
	360,200	47.5	27.6	52.1	31.8	53.7	33.2

#### Mystic System.

Charlestown . . . . .	32,500	33.8	17.8	40.6	24.0	41.5	25.2
Somerville . . . . .	4,400	43.2	26.2	82.1	48.5	78.3	58.8
Chelsea . . . . .	9,300	37.2	24.9	44.4	29.5	43.1	32.3
	46,200	35.3	20.0	45.1	27.3	45.2	29.6

#### ADDITIONAL SUPPLY.

At Dam No. 6 the excavation for the core-wall has been completed, the wall built in the trench, and the trench re-filled. This work was difficult; the building of the core-wall could not be done at a rapid rate, great care being necessary in removing the bracing and in doing the refilling.

The embankment and core-wall of the dam have been built to about five feet above the elevation of the lowest part of the valley, and the work is now in such condition that comparatively rapid progress can be made, all of the difficult work having been done.

The work of stripping the hasin and the shallow-flowage work is well advanced. It will probably be completed this year.

The surveys of Cedar swamp, and the plans for its improvement, are practically completed. At Whitehall pond surveys and borings are being made for a new dam at the outlet; a dredging plant has been built, and the work of removing mud and stumps from the bottom of the pond can be commenced in the spring.

On the Stony-brook branch of the Sudbury, surveys and borings are being made for Basins 5, 7, and 9, the construction of which must soon be commenced, as the increased consumption of water, due to the growth of the city, will keep pace with the increased capacity to be added by the completion of Basin No. 6.

For particulars see the following report of Desmond Fitzgerald, Resident Engineer :

BOSTON WATER-WORKS, OFFICE OF ADDITIONAL SUPPLY,  
SOUTH FRAMINGHAM, MASS., Feb. 1, 1892.

WILLIAM JACKSON, Esq., *City Engineer* :

SIR : I submit herewith a brief report of engineering work accomplished during the past year by the "Additional Supply" force.

The name of Basin 5 has been changed to Basin 6, in order to bring all the even numbers on the Sudbury branch of the supply. Although the core-wall of this basin was heavily covered with hay, the frost got into the trench in January, 1891, and attacked the concrete, even at the bottom of the trench, 30 feet deep, necessitating the laying of steam-pipes. January 9 a contract was made with Charles H. Hale for delivering filling on the dam. April 6 the trench was uncovered and pumped out. May 5 the work of depositing concrete was begun. June 3 the core-wall was completed, and the back-filling begun, the sheeting being cut off in sections about 2 feet high, in order that the back-filling might be thoroughly rammed and bonded to the sides of the trench. On September 2 the back-filling reached the surface of the ground, and the embankment was begun. September 29 the contractor suspended operations, and on October 9 the work was continued by the bondsman, Mr. Barnabas Clark. The embankment has been built to the height of five feet above the meadow. A gap 20 feet wide was left in the core-wall to pass freshets during the winter and spring.

The gate-house for the 48-inch pipe has been built and the

pipe laid on rock foundation and covered with brickwork. It discharges into the wasteway, the lower section of which has been built. The upper gate-house has been begun. All gate-house, pipe, and core-wall trenches have been back-filled.

May 25 a contract was made with Charles H. Hale for building the lower section of the wasteway, 220 feet long, and on September 24 the work was completed.

July 14 four sections for stripping the bottom of the basin were let, and about two-fifths of this work has been done in a satisfactory and economical manner.

During the latter part of the summer a railroad was built connecting the Boston & Albany R.R. with the basin. After its completion about 25,000 cubic yards of loam were hauled to the Muddy-river Improvement on behalf of the town of Brookline.

The principal specifications and contracts prepared during the year were those for the stripping and shallow flowage, the railroad, and the lower section of the wasteway. The following table shows the work accomplished thus far at the new basin :

#### WORK DONE AT BASIN 6 DURING 1890 AND 1891.

	1890.	1891.
Clearing . . . . .	19 acres.	23 acres.
Stripping earth (city contract) . . . . .	47,891 cu. yds.	50,940 cu. yds.
Stripping earth (contract),	0 "	175,000 "
Stripping rock . . . . .	2,125 "	536 "
Collecting stone . . . . .	15,953 "	4,423 "
Trench excavation, earth . . . . .	19,450 "	4,641 "
Trench excavation, rock . . . . .	1,018 "	1,051 "
Crushing stone . . . . .	6,857 "	2,994 "
Concrete . . . . .	7,179 "	2,498 "
Plaster . . . . .	2,174 "	2,132 "
Back-filling . . . . .	507 "	10,875 "
Embankment . . . . .	5,362 "	15,928 "
Screening sand and gravel, . . . . .	4,221 "	2,751 "
Rubble-stone delivered . . . . .	19 "	466 "
Stone-masonry . . . . .	0 "	534 "
Brick-masonry . . . . .	35 "	291 "
Delivering clay (city labor), . . . . .	0 "	593 "
Laying 48-inch pipe . . . . .	0 lin. ft.	414 lin. ft.
Laying 36-inch pipe . . . . .	0 "	12 "
Loaming embankment . . . . .	0 c. y.	322 c. y.
Wasteway . . . . .	0 lin. ft.	220 lin. ft.

Surveys have been continued on various portions of the water-shed. The work of lining the Beacon-street tunnel has been prosecuted from Dec. 30, 1890, to May 14, 1891. The cost of laying the concrete was \$13.14 this year against \$15.02 last year.

Yours very truly,

(Signed)

DESMOND FITZGERALD,

*Resident Engineer.*

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#### IN GENERAL.

The sewerage system of the city of Marlboro' is well advanced, the main sewer is completed, the filtration areas are prepared, and a considerable portion of the service-sewers are laid. The system will be in operation early this year, and it will greatly improve the quality of the water collected by the Stony-brook branch of the Sudbury river.

The sewerage system of the town of Westboro' is under construction, and will probably be in operation in the near future.

Work has been begun upon the foundations of the new pumping-engine at Chestnut-hill pumping-station, and the plans for the engine are nearly completed.

The daily amount pumped at this station increases about 12 per cent. each year, and will exceed the nominal capacity of one pumping-engine next year; consequently the work on the new engine must be pushed as rapidly as possible.

At the Mystic station the pumps are duplicated to a capacity of 10,000,000 gallons per day, and at the present rate of increase the daily average consumption in 1893 will exceed this amount.

In this connection I wish to call attention to the fact that the total capacity of the Mystic system is but 7,000,000 gallons daily in a dry year, and to recommend that the dependant municipalities make some provision to meet the inevitable deficiency which must sooner or later occur.

Thirty-seven contracts for rock excavation have been made during the year. Two hundred and ninety-nine petitions for main-pipe extensions have been reported upon in regard to grade of street, size of pipe, and cost of laying.

The pipe laid has been measured, the gates and hydrants located, and are being plotted on the plans.

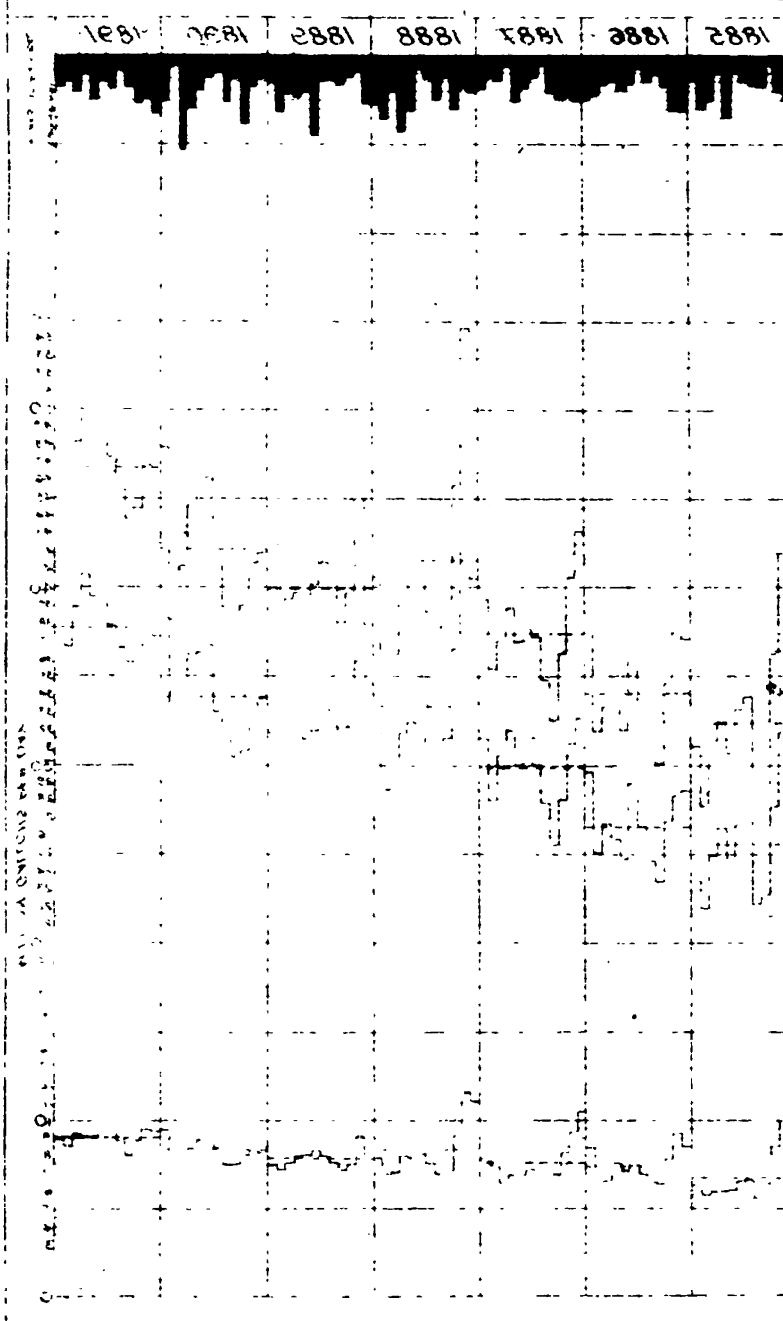
Thirty-five profiles of unaccepted streets have been made, and grades given for grading the streets and laying pipes where it was necessary.

The records from the four pumping-stations, the lakes, reservoirs, the Mystic sewer, and the returns from pipe foundries, etc., have been carefully kept.

Appended to this report will be found the usual tables of rainfall, consumption, yield of water-sheds, etc.

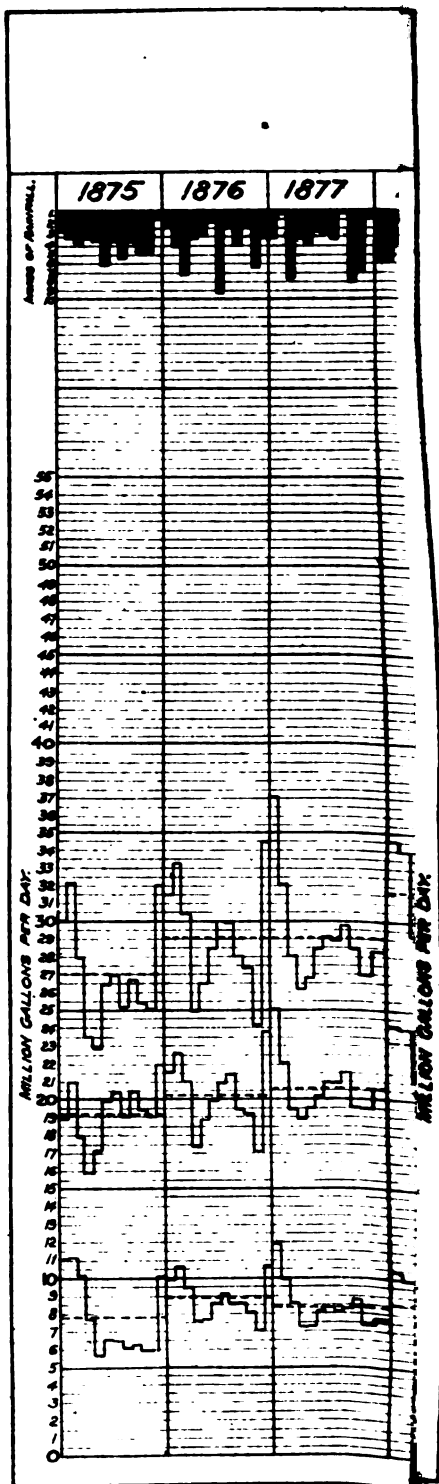
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for constant time



ROW 93

4881



*Daily Average Consumption of Water, in Gallons, from the Cochituate and Mystic Works.*

MYSTIC WORKS.													
	1885.	1886.	1887.	1888.	1889.	1890.	1891.						
January . . . .	7,855,400	8,510,300	10,488,600	11,107,100	7,769,500	8,187,900	9,389,300						
February . . . .	10,019,500	9,275,700	9,346,700	11,020,900	9,073,600	8,299,700	9,466,900						
March . . . . .	8,487,500	7,780,000	8,175,000	9,242,000	7,537,600	8,055,800	8,811,000						
April . . . . .	6,042,600	6,636,500	6,933,800	7,276,700	7,185,700	7,481,600	8,045,800						
May . . . . .	5,605,700	6,444,000	6,916,300	6,932,300	7,663,600	7,488,400	8,841,300						
June . . . . .	6,594,200	6,941,100	7,159,800	7,915,200	8,017,700	8,396,000	9,478,400						
July . . . . .	6,513,300	7,437,500	7,250,000	8,237,500	8,315,600	9,463,300	9,581,700						
August . . . . .	6,047,600	7,166,800	6,871,900	7,859,100	8,113,200	8,932,200	9,122,300						
September . . . .	5,931,900	7,585,200	6,868,600	7,296,300	7,966,000	8,436,700	9,128,700						
October . . . . .	5,914,900	6,552,000	6,436,600	7,096,400	7,627,500	7,784,100	9,259,100						
November . . . .	5,710,300	6,546,000	7,361,200	6,990,800	7,316,700	7,601,300	8,585,200						
December . . . .	6,356,700	8,043,500	7,885,300	7,913,600	7,473,200	9,448,300	8,960,600						
Yearly average .	6,737,350	7,399,800	7,629,000	8,258,400	7,830,500	8,301,400	9,055,200						

COCHITUATE WORKS.							
MONTH.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
January . . . .	26,711,900	28,561,900	32,687,600	40,485,700	30,172,000	33,680,000	37,230,100
February . . . .	31,847,400	28,221,100	31,224,300	43,105,000	35,855,200	33,030,700	37,280,700
March . . . . .	27,697,200	26,863,800	28,124,100	36,463,400	32,180,000	30,844,400	35,533,400
April . . . . .	22,720,450	23,470,400	25,591,500	31,473,800	30,814,500	30,446,600	33,751,600
May . . . . .	22,168,400	24,080,100	27,025,000	30,802,000	32,719,500	31,331,200	36,580,700
June . . . . .	27,214,800	26,574,900	30,069,000	31,026,100	33,377,900	33,022,700	37,801,900
July . . . . .	26,606,200	28,987,500	30,469,700	32,014,400	31,870,300	36,701,100	39,062,600
August . . . . .	24,686,400	24,770,600	30,063,100	32,432,700	31,403,200	36,316,000	39,460,400
September . . . .	26,493,600	25,835,600	31,946,600	31,836,500	31,722,800	36,165,800	40,677,700
October . . . . .	24,945,500	26,713,100	30,562,700	29,110,800	31,702,200	33,429,800	38,845,600
November . . . .	21,942,750	25,036,200	28,062,000	28,590,900	31,532,400	32,955,100	36,640,800
December . . . .	24,724,900	29,706,800	31,511,500	32,686,200	31,829,000	38,334,100	37,342,500
Yearly average .	25,607,200	26,627,900	29,852,100	33,310,700	32,070,000	33,871,700	37,586,900



*Division of Sudbury-River Water, 1883-91.*

MONTH.	1893.		1894.		1895.		1896.		1897.		1898.		1899.		1900.		1901.	
	To Lake Cochituate.	To Chestnut- Hill Res'r.	To Lake Cochituate.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Lake Cochituate.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.	To Chestnut- Hill Res'r.
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.
January . . . . .	733,400,000	697,000,000	697,000,000	473,900,000	502,200,000	692,200,000	886,400,000	484,600,000	618,600,000	715,900,000	518,600,000	618,600,000	484,600,000	618,600,000	715,900,000	518,600,000	618,600,000	715,900,000
February . . . . .	597,800,000	1,094,300,000	265,400,000	500,400,000	380,800,000	472,000,000	906,700,000	504,800,000	475,000,000	560,800,000	475,000,000	475,000,000	504,800,000	475,000,000	560,800,000	475,000,000	475,000,000	560,800,000
March . . . . .	17,200,000	634,700,000	312,500,000	495,900,000	467,400,000	456,700,000	691,400,000	584,500,000	498,600,000	673,200,000	498,600,000	498,600,000	584,500,000	498,600,000	673,200,000	498,600,000	498,600,000	673,200,000
April . . . . .	987,900,000	535,700,000	228,800,000	350,400,000	307,000,000	885,400,000	468,800,000	490,500,000	417,000,000	641,600,000	417,000,000	417,000,000	490,500,000	417,000,000	641,600,000	417,000,000	417,000,000	641,600,000
May . . . . .	280,000,000	613,800,000	269,400,000	308,500,000	344,700,000	444,200,000	566,300,000	615,700,000	536,300,000	740,300,000	536,300,000	536,300,000	615,700,000	536,300,000	740,300,000	536,300,000	536,300,000	740,300,000
June . . . . .	631,600,000	414,500,000	108,400,000	708,000,000	437,100,000	468,600,000	489,000,000	597,600,000	613,100,000	629,500,000	613,100,000	613,100,000	597,600,000	613,100,000	629,500,000	613,100,000	613,100,000	629,500,000
July . . . . .	754,300,000	430,100,000	182,000,000	434,600,000	534,500,000	387,500,000	528,900,000	534,000,000	664,100,000	765,100,000	534,000,000	534,000,000	534,000,000	664,100,000	765,100,000	534,000,000	534,000,000	765,100,000
August . . . . .	640,900,000	406,100,000	1,600,000	401,100,000	463,100,000	362,800,000	626,600,000	443,700,000	693,500,000	722,000,000	693,500,000	693,500,000	443,700,000	693,500,000	722,000,000	693,500,000	693,500,000	722,000,000
September . . . . .	467,100,000	442,200,000	386,100,000	386,100,000	414,700,000	577,300,000	581,600,000	475,500,000	606,400,000	732,400,000	606,400,000	606,400,000	475,500,000	606,400,000	732,400,000	606,400,000	606,400,000	732,400,000
October . . . . .	433,300,000	432,900,000	368,300,000	368,300,000	474,100,000	672,300,000	485,900,000	414,100,000	539,900,000	715,300,000	539,900,000	539,900,000	414,100,000	539,900,000	715,300,000	539,900,000	539,900,000	715,300,000
November . . . . .	580,800,000	363,900,000	297,600,000	297,600,000	331,800,000	607,100,000	410,900,000	454,600,000	526,000,000	762,300,000	526,000,000	526,000,000	454,600,000	526,000,000	762,300,000	526,000,000	526,000,000	762,300,000
December . . . . .	536,800,000	432,500,000	379,900,000	379,900,000	570,200,000	703,000,000	605,200,000	501,200,000	675,600,000	767,100,000	675,600,000	675,600,000	501,200,000	675,600,000	767,100,000	675,600,000	675,600,000	767,100,000
Totals . . . . .	1,246,100,000	7,209,900,000	1,416,300,000	6,224,700,000	6,287,600,000	6,124,100,000	7,224,700,000	6,130,500,000	6,596,000,000	8,306,600,000	6,596,000,000	6,596,000,000	6,130,500,000	6,596,000,000	8,306,600,000	6,596,000,000	6,596,000,000	8,306,600,000
Total diversion from Sud- bury river }	8,465,000,000	6,110,600,000	16,606,600	5,224,700,000	5,287,600,000	6,124,100,000	7,224,700,000	6,363,900,000	18,071,200	22,757,800	6,363,900,000	6,363,900,000	6,363,900,000	18,071,200	22,757,800	6,363,900,000	6,363,900,000	22,757,800
Average daily diversion for whole year }	28,164,400	16,606,600	14,431,800	14,314,200	14,431,800	16,778,600	19,799,600	17,435,300	18,071,200	22,757,800	17,435,300	17,435,300	18,071,200	18,071,200	22,757,800	18,071,200	18,071,200	22,757,800

*Statement showing Amount of Water diverted from Sudbury River to Lake Cochituate and Chestnut-Hill Reservoir; Amount wasted; Amount of Flow in River; Percentage of Rainfall collected, etc., 1875 to 1891.*

(Water-shed from 1875 to 1878, inclusive, = 77,764 sq. miles; in 1879 and 1880 = 78,233 sq. miles; and from 1881 to 1891, inclusive, = 75.2 sq. miles.)

YEAR.	Amount of Water diverted to Lake Cochituate and Chestnut-Hill Reservoir.	Amount of Water used by Framingham Water Co.	Amount of Water wasted from River.	STORAGE.		Total amount of flow in River.	Daily average amount of flow in River.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1875 . . . .	2,555,800,000	..	24,971,600,000	66,300,000	..	27,568,700,000	76,599,200	45.490	20.418	44.88
1876 . . . .	2,628,300,000	..	29,942,300,000	..	160,700,000	32,309,900,000	88,278,400	49.563	23.908	48.24
1877 . . . .	1,864,350,000	..	32,438,300,000	112,100,000	..	34,444,750,000	94,300,200	44.018	25.487	57.90
1878 . . . .	3,422,100,000	..	37,125,200,000	654,700,000	..	41,202,000,000	112,832,200	57.931	30.487	52.63
1879 . . . .	3,749,200,000	..	20,817,500,000	982,200,000	..	25,528,900,000	66,942,200	41.419	18.776	45.33
1880 . . . .	6,230,200,000	..	11,290,000,000	..	958,600,000	16,661,600,000	42,250,300	38.177	12.182	31.91
1881 . . . .	8,845,300,000	..	17,279,000,000	761,700,000	..	26,876,000,000	73,633,900	44.169	20.565	49.56
1882 . . . .	7,735,200,000	..	16,273,000,000	..	352,600,000	23,656,600,000	64,812,300	39.394	18.102	45.95
1883 . . . .	8,455,000,000	..	7,251,900,000	..	1,066,400,000	14,690,500,000	40,066,200	32.780	11.188	34.13
1884 . . . .	6,110,600,000	..	23,228,900,000	1,744,600,000	..	31,084,100,000	84,929,200	47.136	23.784	50.46
1885 . . . .	5,224,700,000	61,800,000	19,878,800,000	..	446,900,000	24,718,400,000	67,721,600	43.545	18.916	43.44
1886 . . . .	6,266,600,000	76,600,000	23,022,000,000	1,464,600,000	..	29,831,700,000	81,730,700	49.065	22.825	49.56
1887 . . . .	6,124,100,000	87,600,000	25,234,500,000	117,400,000	..	31,663,500,000	86,749,300	42.706	24.227	56.73
1888 . . . .	7,224,700,000	61,600,000	39,040,500,000	390,600,000	..	46,717,300,000	127,642,900	57.465	36.749	62.21
1889 . . . .	6,363,900,000	56,500,000	31,550,400,000	..	2,800,000	37,971,000,000	104,030,100	49.95	20.055	53.17
1890 . . . .	6,596,000,000	74,500,000	23,667,100,000	..	57,400,000	35,280,200,000	96,648,100	53.00	26.993	50.94
1891 . . . .	8,306,600,000	80,500,000	23,799,600,000	..	1,100,800,000	36,065,900,000	98,846,500	49.62	27.612	55.76
Average . .	5,684,332,400	71,700,000	24,524,100,000	..	..	30,831,361,800	82,949,600	46.019	22.957	49.10

*Statement showing Amount of Water drawn from Lake Oochiwate ; Amount wasted ; Amount of Rainfall collected in Lake ; Amount received into Lake from Sudbury River ; Percentage of Rainfall collected, etc., 1852 to 1891 ; Water-shed of Lake, 12,077 Acres.*

YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Amount received into Lake from Sudbury River.	STORAGE.		Total amount of Rainfall collected in Lake.	Daily average amount of Rain- fall collected in Lake.	Rainfall. collected.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1852 <sup>1</sup> . . . . .	2,974,042,800	4,020,566,900	. . . . .	. . . . .	261,360,000	6,738,249,700	18,806,900	47.98	20.61	43.
1853 . . . . .	3,117,939,500	3,166,417,500	. . . . .	236,580,000	. . . . .	6,523,937,000	17,873,800	56.73	19.51	36.
1854 . . . . .	3,614,230,000	4,187,733,000	. . . . .	. . . . .	217,800,000	7,564,163,000	20,778,500	43.15	22.37	33.
1855 . . . . .	3,776,369,500	No account kept	. . . . .	. . . . .	828,700,000	. . . . .	. . . . .	34.96	. . . . .	. . . . .
1856 . . . . .	4,409,787,600	"	. . . . .	593,950,000	. . . . .	. . . . .	. . . . .	40.30	. . . . .	. . . . .
1857 . . . . .	4,644,990,000	10,625,000,000	. . . . .	82,370,000	. . . . .	16,308,560,000	41,927,600	63.10	46.69	74.
1858 . . . . .	4,686,155,000	1,324,500,000	. . . . .	. . . . .	141,570,600	6,493,086,000	17,769,000	43.66	19.46	40.
1859 <sup>2</sup> . . . . .	4,806,375,000	7,569,000,000	. . . . .	263,140,000	. . . . .	12,461,016,000	34,687,700	49.02	38.24	76.
1860 . . . . .	6,309,108,000	None.	. . . . .	174,240,000	. . . . .	6,483,348,000	17,714,100	55.44	19.40	35.
1861 . . . . .	6,689,096,900	3,377,559,000	. . . . .	. . . . .	1,459,260,000	8,537,394,900	23,444,900	45.44	25.45	56.
1862 . . . . .	6,059,000,000	33,200,000	. . . . .	1,306,900,000	. . . . .	7,399,000,000	20,271,200	49.69	22.36	45.
1863 . . . . .	5,927,052,500	2,165,696,500	. . . . .	762,300,000	. . . . .	8,855,049,000	24,260,400	66.30	26.38	39.
1864 . . . . .	6,106,306,700	1,398,746,000	. . . . .	. . . . .	1,848,577,000	5,632,475,700	16,370,200	42.60	18.35	43.
1865 . . . . .	4,621,630,000	1,689,120,700	. . . . .	743,242,600	. . . . .	7,062,993,200	19,323,300	49.46	20.50	41.
1866 . . . . .	4,463,565,000	None.	. . . . .	743,242,600	. . . . .	5,306,827,500	14,266,300	62.32	16.01	26.
1867 . . . . .	4,951,225,000	2,492,941,000	. . . . .	. . . . .	998,811,000	6,784,465,000	18,450,600	56.26	21.80	39.
1868 . . . . .	5,405,515,000	2,507,684,000	. . . . .	846,371,000	. . . . .	8,286,870,000	22,567,300	49.71	24.98	50.

## ENGINEERING DEPARTMENT.

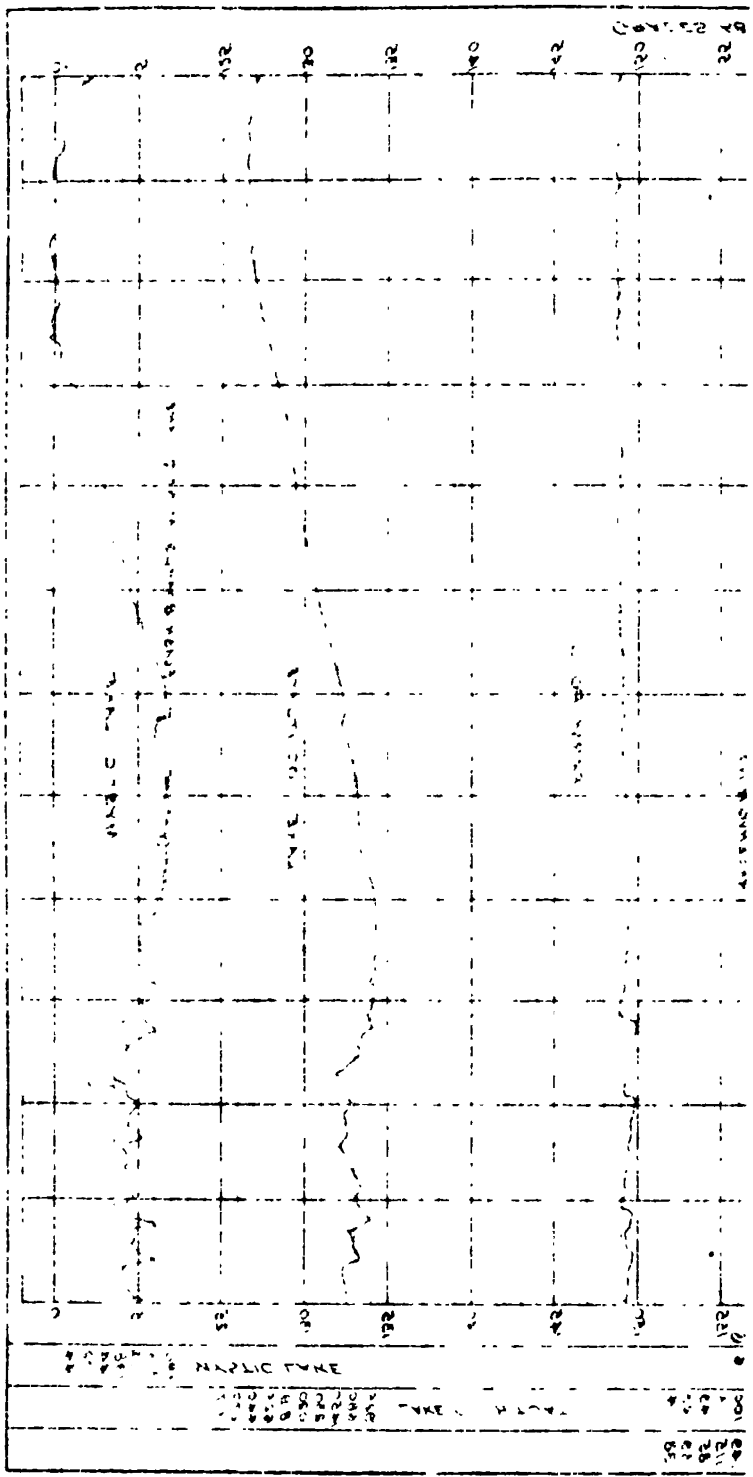
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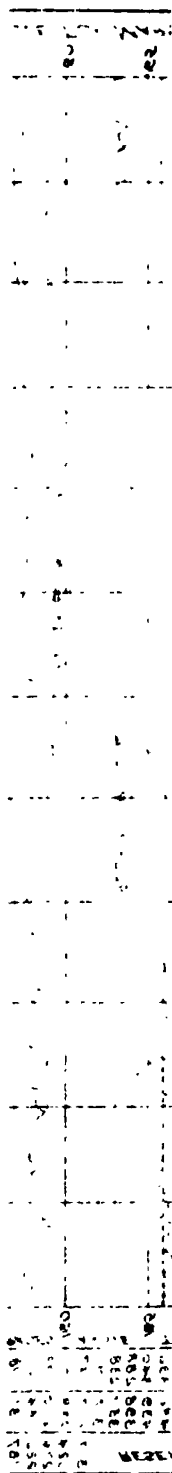
1866	5,508,751,000	1,635,570,000	.....	480,882,000	.....	7,620,203,000	20,877,300	64.34	21.99	34.
1870	5,477,810,000	4,818,971,000	.....	.....	1,736,085,000	8,660,696,000	22,453,900	55.89	26.08	47.
1871	5,223,500,000	None.	.....	.....	250,832,000	4,972,507,000	19,923,500	45.39	16.16	33.
1872	5,775,151,200	None.	.....	.....	.....	5,642,480,300	16,416,600	48.47	17.22	35.
1873	6,511,826,900	2,917,977,000	.....	.....	.....	8,914,671,900	24,423,800	45.43	27.13	60.
1874	6,622,972,900	1,145,851,700	.....	.....	.....	6,402,109,600	17,540,000	35.93	19.52	54.
1875	7,092,935,500	None.	.....	.....	.....	5,760,040,500	15,780,900	45.49	17.57	38.
1876	7,377,175,200	1,619,243,800	.....	.....	.....	6,411,667,000	17,517,900	48.49	19.54	40.
1877	7,626,889,200	1,494,978,600	.....	.....	.....	7,696,244,800	20,811,600	43.80	23.17	53.
1878	7,743,904,700	2,341,876,000	.....	.....	.....	8,637,268,700	23,663,700	53.58	26.34	49.
1879	6,051,838,900	1,628,361,400	.....	.....	.....	5,841,203,000	16,003,300	38.01	17.81	47.
1880	4,284,147,100	66,577,700	.....	.....	.....	3,376,759,800	9,226,100	36.88	10.30	26.
1881	2,846,459,700	2,231,016,700	.....	.....	.....	5,257,965,800	14,679,400	41.09	16.34	40.
1882	3,935,490,800	1,358,543,700	.....	.....	.....	4,936,699,600	13,522,200	40.29	15.06	37.
1883	4,731,227,700	1,842,837,100	.....	.....	.....	3,314,089,500	9,079,700	31.20	10.11	32.
1884	4,533,156,450	1,006,622,800	.....	.....	.....	6,300,130,250	17,213,450	45.57	19.21	42.
1885	4,091,674,900	3,116,283,200	.....	.....	.....	5,108,892,500	13,991,500	43.66	15.67	36.
1886	4,432,586,100	3,658,652,900	.....	.....	.....	7,188,157,300	19,693,600	46.97	21.92	47.
1887	4,802,120,700	4,229,200,000	.....	.....	.....	7,697,568,600	21,086,200	41.58	23.47	56.
1888	4,968,503,100	3,373,929,000	.....	.....	.....	10,157,012,100	37,751,400	56.93	30.97	54.
1889	5,570,423,800	2,390,441,200	.....	.....	.....	9,165,719,400	25,111,600	50.23	27.95	56.
1890	5,722,170,800	6,064,000,000	.....	.....	.....	8,038,445,700	22,025,100	51.23	24.51	48.
1891	5,508,178,900	.....	.....	.....	.....	10,516,121,100	28,811,300	46.42	33.07	69.
Averages	5,231,296,100	2,460,125,200	.....	.....	.....	7,298,861,200	19,958,000.	47.98	22.16	46.

<sup>1</sup> Observation of rainfall at Lake Coohituate commenced 1893, and these observations are assumed as correct for the whole district.  
<sup>2</sup> Lake raised two feet.

*Statement showing Amount of Water drawn from Mystic Lake; Amount wasted; Amount of Rainfall collected in Lake; Percentage of Rainfall collected, etc., 1876 to 1891; Water-shed of Lake, 17,200 Acres.*

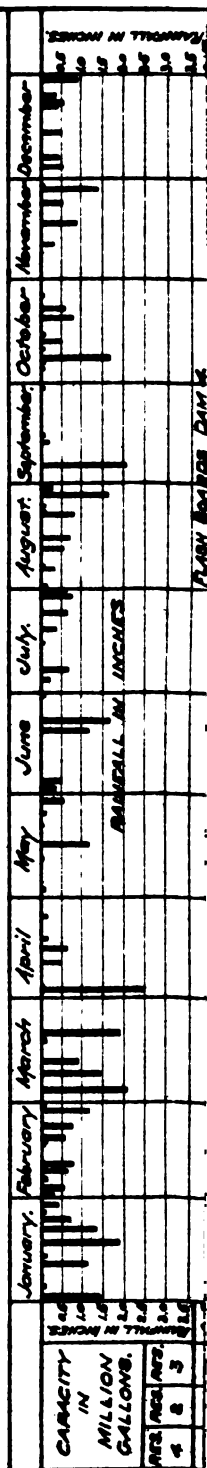
YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	STORAGE.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall col- lected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
			Gain.	Loss.					
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Inches.	Inches.	Per cent.
1876 . . . . .	3,220,101,300	6,390,774,700	. . . . .	32,583,000	9,587,293,000	26,140,100	47.00	20.46	43.6
1877 . . . . .	3,069,554,800	7,250,223,500	. . . . .	16,291,400	10,803,188,900	28,228,700	43.096	22.06	51.2
1878 . . . . .	3,367,490,400	8,718,547,900	. . . . .	26,000,000	12,060,688,000	33,041,200	54.086	25.92	47.8
1879 . . . . .	3,490,848,200	4,625,691,800	. . . . .	203,000,000	7,913,540,000	21,680,900	35.30	16.94	48.0
1880 . . . . .	3,692,195,700	2,118,761,200	. . . . .	113,500,000	5,708,756,900	15,584,000	34.42	12.21	35.5
1881 . . . . .	2,815,579,900	5,584,300,000	371,200,000	. . . . .	8,721,079,900	23,868,400	41.91	18.67	44.5
1882 . . . . .	2,570,896,700	4,444,668,000	15,000,000	. . . . .	7,030,564,700	19,261,800	36.166	15.06	38.4
1883 . . . . .	2,664,514,200	2,034,702,600	. . . . .	347,579,000	4,351,637,800	11,922,300	31.22	9.32	26.84
1884 . . . . .	2,469,761,000	6,574,003,900	380,300,000	. . . . .	9,424,364,800	25,749,600	44.39	20.18	46.46
1885 . . . . .	2,639,278,800	5,568,960,500	. . . . .	33,200,000	8,194,389,300	22,451,900	44.50	17.55	39.43
1886 . . . . .	2,862,947,500	7,748,298,900	. . . . .	28,400,000	10,577,966,400	28,980,300	45.56	22.06	49.71
1887 . . . . .	2,964,257,500	7,414,213,000	. . . . .	11,000,000	10,357,470,500	28,376,600	46.42	22.17	47.77
1888 . . . . .	3,205,121,100	11,334,598,100	. . . . .	6,000,000	14,632,714,200	39,709,600	56.745	31.12	54.94
1889 . . . . .	3,007,589,800	8,879,787,600	. . . . .	. . . . .	11,899,327,300	32,600,900	50.396	25.48	50.50
1890 . . . . .	3,212,284,600	8,968,727,900	12,000,000	3,000,000	12,169,012,400	33,323,300	49.37	26.04	52.75
1891 . . . . .	3,600,817,600	10,027,714,400	. . . . .	171,000,000	13,357,431,900	36,600,000	47.40	28.40	60.34
Average . . . . .	3,047,074,300	6,728,801,800	. . . . .	. . . . .	9,769,472,900	26,721,200	44.436	30.90	46.23





**BOSTON WATER WORKS.**

Diagram showing the heights of Sudbury River Reservoirs, Farm Pond, and Cochituate and Mystic Lakes; and the Rainfall on the Sudbury River Water Shed during the year 1891.



*Table showing the Average Monthly and Yearly Heights above Tide-march Level of the Water in the Lakes and Reservoirs of the Boston Water Works.*

MONTHS.	Reservoir No. 1. Flash boards. 159.29.		Reservoir No. 2. Flash boards. 167.12.		Reservoir No. 3. Stone crest. 175.24.		Reservoir No. 4. Flash boards. 215.21.		Farm Pond. High water. 149.25.		Lake Cochituate. High water. 134.36.		Chestnut-Hill Reservoir. High water. 124.00.		Brookline Reservoir. High water. 124.00.		Parker-Hill Reservoir. High water. 219.00.		Mystic Lake. High water. 7.00.		Mystic Reservoir. High water. 147.00.		Fisher-Hill Reservoir. High water. 241.00.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
January	157.95	158.23	166.12	166.20	175.55	175.32	214.53	213.85	149.64	149.48	132.49	132.95	123.45	123.48	123.02	123.25	—	—	—	—	—	—	—	—
February	157.99	158.33	166.15	166.06	175.57	174.41	214.54	210.14	149.27	149.53	132.38	132.73	123.42	123.43	123.24	123.20	218.48	218.77	4.56	146.77	146.87	236.47	240.22	240.22
March	158.39	158.45	164.63	165.57	173.92	172.73	213.53	210.35	149.54	149.50	132.30	133.13	123.43	123.27	123.27	123.06	218.75	218.75	4.79	146.81	146.85	239.01	240.34	240.34
April	158.09	158.15	166.18	166.12	175.56	175.59	214.59	214.35	149.29	149.33	133.03	134.23	123.47	123.52	123.31	123.32	218.63	218.76	5.81	146.61	146.63	239.04	240.17	240.17
May	157.96	158.64	166.57	166.59	175.56	175.30	214.54	214.50	149.60	149.32	133.82	133.56	123.79	123.47	123.45	123.02	218.49	218.71	6.44	146.55	146.52	239.00	240.00	240.00
June	158.80	159.36	167.18	165.36	175.45	175.37	214.71	214.84	149.59	149.17	133.56	132.68	123.79	123.70	123.61	123.47	218.36	218.71	6.55	146.43	146.57	239.48	240.10	240.10
July	159.09	157.57	162.37	162.79	175.17	175.30	213.90	214.07	149.15	148.96	131.99	131.44	123.81	123.76	123.58	123.50	218.65	218.83	5.73	146.09	146.90	239.89	240.60	240.60
August	158.67	157.77	160.86	158.86	174.21	175.00	208.51	208.92	148.85	148.83	130.34	130.04	123.82	123.86	123.59	123.58	218.90	218.90	3.82	146.82	146.93	239.67	240.46	240.46
September	157.63	157.88	164.02	160.47	175.14	173.17	202.33	204.72	149.07	148.94	129.55	129.02	123.77	123.99	123.54	123.43	218.76	218.67	3.31	146.70	146.54	239.59	240.35	240.35
October	157.99	157.44	165.85	158.51	175.62	169.84	205.15	203.35	149.54	148.31	130.38	127.67	123.86	123.69	123.53	123.43	218.96	218.69	4.68	146.58	146.56	240.05	240.61	240.61
November	157.92	156.97	166.13	158.64	175.52	164.60	212.53	204.41	149.19	148.75	132.47	126.71	123.88	123.82	123.68	123.31	218.89	218.60	5.66	146.61	146.90	240.39	240.73	240.73
December	157.84	157.00	166.09	162.15	175.47	164.03	214.13	206.51	149.26	148.84	132.64	126.72	123.53	123.73	123.03	123.51	218.74	218.91	5.48	146.70	146.84	239.82	240.62	240.62
Yearly averages	158.19	157.98	165.18	163.11	175.23	172.34	211.92	209.99	149.33	149.12	132.08	130.91	123.67	123.62	123.40	123.34	218.69	218.76	5.31	146.67	146.78	239.55	240.36	240.36



## Statement of Operations at the Chestnut-Hill Pumping-Station for 1891.

1891.	Engine No. 1.		Engine No. 2.		Total amount pumped.		Daily amount pumped.	Total amount of coal consumed.		Daily average amount of coal consumed.	Total ashes and clinkers.	Per cent. ashes	Quantity pumped per lb. of coal. No correction for heating and lighting.	Quantity pumped per lb. of coal. Corrected for heating and lighting.	Average lift in feet.	Duty in ft.-lbs. per 100 lbs. of coal.			Water evaporated in boiler per lb. of coal.	
	Total pump- ing- time.		Amount pumped.		Gallons.	Gallons.		Lbs.	Lbs.							Feet.	Without correction for heating and lighting.	Corrected for heating buildings.	Corrected for heating and lighting.	Lbs.
	Hrs.	Min.	Gallons.	Hrs.			Min.			Gallons.	Gallons.	Lbs.	Cent.	Gallons.	Feet.					
Month.																				
Jan. . . . .				596	15	209,531,125	6,759,100	245,844	7,930	21,504	8.7	852.3	957.1	123.66	87,899,100	93,436,700	98,669,200	10.26	12.10	
Feb. . . . .	533	00	188,962,250			188,962,250	6,748,700	216,763	7,742	18,568	8.6	871.7	975.4	124.05	90,188,900	95,780,600	100,952,800	10.28	12.11	
March . . . .				579	00	205,505,850	6,629,200	235,933	7,611	20,706	8.8	871.0	964.2	124.72	90,602,000	95,494,500	100,269,200	10.17	11.98	
April . . . . .	550	15	197,856,500			197,856,500	6,595,200	220,362	7,345	19,419	8.8	867.9	972.4	124.24	93,033,900	96,383,100	100,720,300	10.26	12.02	
May . . . . .				620	00	221,006,625	7,129,200	240,462	7,757	20,988	8.7	919.1	974.2	124.35	95,317,100	97,509,400	101,019,700	10.20	11.88	
June . . . . .	633	00	230,849,300			230,849,300	7,695,000	237,339	7,911	19,623	8.3	972.7	1004.8	123.85	100,466,600	103,782,000	108,782,000	10.29	11.92	
July . . . . .				629	40	237,948,475	7,675,800	248,657	8,021	19,474	7.8	956.9	986.6	124.72	99,537,000	102,622,600	104,490,000	10.40	12.12	
Aug. . . . .	617	10	234,275,135			234,275,135	7,557,300	241,270	7,783	18,919	7.8	971.0	1009.8	124.55	100,863,200	104,897,700	109,897,700	10.50	12.09	
Sept. . . . .	405	00	190,820,750	128	15	49,704,525	8,020,500	252,335	8,411	20,965	8.3	983.6	994.6	124.93	99,352,400	103,624,000	104,490,000	10.46	12.07	
Oct. . . . .				619	00	237,324,550	7,655,600	258,957	8,353	22,310	8.6	916.5	974.2	125.32	95,785,900	97,031,100	101,785,000	10.49	12.19	
Nov. . . . .	582	00	221,711,675			221,711,675	7,390,400	246,834	8,228	21,578	8.7	898.2	976.3	125.43	93,061,800	96,780,700	102,103,000	10.40	12.19	
Dec. . . . .				506	15	225,577,650	7,276,700	295,996	8,580	24,517	9.2	848.1	923.6	125.42	89,709,500	91,456,400	96,578,000	10.31	12.15	
Totals and averages,	3419	25	1,264,476,610	3768	25	1,386,088,800	7,263,500	2,910,751	7,975	248,566	8.5	910.8	975.5	124.66	94,648,000	97,015,100	101,380,800	10.34	12.06	

Statement of Operations at the Mystic Pumping-Station for 1891.

1891.	ENGINE No. 1.			ENGINE No. 2.			ENGINE No. 3.			Total amount pumped.	Gallons.	Daily average amount pumped.	Lbs.	Daily average amount of coal consumed.	Lbs.	Daily average amount of ashes and clinkers.	Per cent.	Quantity pumped of coal.	Average lift in feet.	Duty in foot-pounds per 100 coal.
	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.											
	Hrs.	Min.		Hrs.	Min.		Hrs.	Min.												
Month.	Hrs.	Min.	Gallons.	Hrs.	Min.	Gallons.	Hrs.	Min.	Gallons.	Hrs.	Min.	Gallons.	Hrs.	Min.	Gallons.	Hrs.	Min.	Gallons.	Hrs.	Min.
January . . . . .	29	15	5,390,700	96	00	17,470,700	730	00	251,827,200	274,688,600	8,860,900	18,258	1,836	10.1	485.2	146.99	59,494,700	58,628,100	147.17	58,628,100
February . . . . .	288	45	48,984,200	439	00	92,004,300	443	45	143,001,600	283,960,100	9,465,300	21,750	2,228	10.2	435.2	147.97	53,705,200	60,028,200	147.17	58,628,100
March . . . . .	8	15	1,615,700	237	45	46,643,900	734	15	249,164,800	297,424,400	9,564,300	20,097	2,120	10.6	477.4	148.30	59,046,700	59,686,100	146.66	60,028,200
April . . . . .	19	30	3,790,100	155	30	29,173,200	744	00	249,625,600	282,588,900	9,115,800	18,681	1,924	10.4	490.6	148.42	60,728,300	59,686,100	146.94	59,686,100
May . . . . .	108	45	30,569,600	62	00	12,617,900	692	30	229,604,800	273,715,300	9,123,800	19,133	2,007	10.5	476.9	148.56	59,082,000	59,494,700	148.99	59,494,700
June . . . . .	289	30	54,843,200	41	45	8,471,100	676	30	224,183,600	287,467,900	9,273,200	20,129	2,064	10.4	460.7	148.47	57,428,100	60,028,200	147.97	53,705,200
July . . . . .	181	30	24,190,200	720	00	232,524,800	720	00	232,524,800	266,715,000	8,587,200	18,067	1,863	10.3	473.6	149.81	60,177,800	59,686,100	148.30	59,046,700
August . . . . .	146	45	27,617,900	742	30	260,188,800	742	30	260,188,800	277,806,700	8,961,500	19,274	1,900	9.9	464.9	149.27	57,882,000	58,628,100	148.42	60,728,300
September . . . . .	864	00	145,186,600	1,777	15	346,862,100	8,352	30	2,812,902,400	3,304,931,000	9,084,700	19,147	1,960	10.2	472.9	148.02	58,380,500	59,494,700	148.56	59,082,000
October . . . . .																				
November . . . . .																				
December . . . . .																				
Totals and averages																				

*Rainfall in Inches and Hundredths on the Sudbury River Water-shed for the Year 1891.*

1891.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. . . . .	...	0.340	...	...	...	...	...	0.130	...	...	...	...
2. . . . .	1.425	...	...	...	...	0.385	...	...	...	...	...	...
3. . . . .	...	0.545	...	2.480	0.100	...	...	...	...	...	...	...
4. . . . .	...	...	2.065	0.010	...	0.500	0.225	...	...	...	...	0.565
5. . . . .	0.105	...	...	...	...	...	...	...	...	0.115	...	...
6. . . . .	...	0.155	...	...	...	...	...	0.345	2.040	...	...	...
7. . . . .	...	...	...	...	...	...	0.715	0.070	...	0.020	...	0.415
8. . . . .	...	0.650	...	...	...	...	...	...	...	1.665	...	...
9. . . . .	...	...	1.455	...	...	...	...	...	...	...	...	...
10. . . . .	...	0.770	...	...	...	...	...	...	...	...	...	...
11. . . . .	...	...	...	0.480	...	...	...	...	...	0.065	0.330	...
12. . . . .	1.130	...	...	...	0.070	...	...	0.525	...	...	...	...
13. . . . .	...	...	0.900	...	...	...	...	...	0.190	0.495	...	...
14. . . . .	0.035	...	...	...	...	...	...	...	...	...	...	...
15. . . . .	...	...	...	0.635	...	...	0.020	0.780	0.070	0.020	...	0.475
16. . . . .	...	0.070	...	...	1.160	...	...	...	...	...	...	...
17. . . . .	...	0.120	...	...	...	...	...	...	...	...	0.830	...
18. . . . .	1.875	0.550	...	0.160	...	...	...	...	...	...	...	...
19. . . . .	...	...	0.110	...	...	1.195	0.355	...	...	...	...	...
20. . . . .	...	...	...	...	...	...	...	...	...	0.770	...	...
21. . . . .	...	0.750	1.945	...	...	...	...	...	...	...	...	...
22. . . . .	1.295	...	...	...	0.030	1.675	...	0.810	...	...	...	...
23. . . . .	...	...	...	...	...	...	...	0.110	...	0.575	0.500	0.380
24. . . . .	...	...	...	...	...	...	0.655	...	...	...	...	0.640
25. . . . .	0.725	...	...	0.140	...	...	...	0.010	...	...	...	...
26. . . . .	...	1.185	...	...	0.100	...	...	...	...	...	...	0.330
27. . . . .	0.040	...	...	...	...	...	...	...	...	0.085	1.400	...
28. . . . .	...	0.100	...	...	...	...	...	1.645	...	...	0.040	...
29. . . . .	0.390	...	...	...	0.540	...	0.785	...	0.080	...	...	...
30. . . . .	...	...	...	...	...	0.015	...	0.285	...	...	...	0.880
31. . . . .	...	...	...	...	...	...	0.640	0.065	...	...	...	...
Totals. .	7.020	5.235	6.475	3.905	2.010	3.770	3.395	4.725	2.380	3.830	3.090	3.565

Total rainfall during the year, 49.520 inches, being an average of two gauges, located at Framingham and Ashland.

*Rainfall in Inches and Hundredths at Lake Cochituate for the Year 1891.*

1891.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. . . . .		0.34						0.12				
2. . . . .	1.33					0.53						
3. . . . .		0.42		2.40	0.12							
4. . . . .			1.63			0.33	0.18					0.38
5. . . . .	0.31									0.35		
6. . . . .		0.18						0.49	1.77			
7. . . . .							0.64	0.01				0.23
8. . . . .		0.70								1.78		
9. . . . .			1.26									
10. . . . .		0.80										
11. . . . .				0.39						0.07	0.31	
12. . . . .	1.01				0.06			0.77				
13. . . . .			0.76						0.23	0.53		
14. . . . .	0.08											
15. . . . .				0.60			0.03	0.61	0.04	0.08		0.54
16. . . . .		0.08			0.82							
17. . . . .											0.31	
18. . . . .	2.00	0.59		0.16	0.01							
19. . . . .			0.08			1.02	0.34					
20. . . . .										0.65		
21. . . . .		0.71										
22. . . . .	1.05		1.76			1.37		0.76				
23. . . . .								0.03		0.60	0.37	0.33
24. . . . .							0.63					
25. . . . .	0.67			0.07								
26. . . . .		1.17			0.15							0.91
27. . . . .	0.02									0.11	1.33	
28. . . . .		0.13						1.33	0.06		0.02	
29. . . . .	0.35					0.03	0.58					
30. . . . .					0.51							0.30
31. . . . .							0.54	0.29				
Totals . .	6.67	5.02	5.49	3.62	1.67	3.78	2.90	4.91	2.12	4.14	2.84	3.17

Total rainfall during the year, 46.42 inches.

*Rainfall in Inches and Hundredths on the Mystic Lake Water-shed for the Year 1891.*

1891.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. ....	...	0.540	...	...	...	...	...	0.025	...	...	...	...
2. ....	1.130	...	...	...	...	0.305	...	...	...	...	...	...
3. ....	...	0.480	...	2.135	0.120	0.386	0.005	...	...	...	...	...
4. ....	...	...	1.920	...	...	0.015	0.185	...	...	...	...	0.265
5. ....	0.145	...	...	...	...	...	...	...	...	0.195	...	...
6. ....	...	0.215	...	...	...	...	...	0.585	1.825	...	0.005	...
7. ....	...	...	...	...	0.020	...	0.710	0.130	...	...	...	0.280
8. ....	...	0.680	...	...	...	...	...	...	...	1.505	...	...
9. ....	...	...	0.905	...	...	...	...	...	...	...	...	...
10. ....	...	0.785	...	...	...	...	...	...	...	...	...	...
11. ....	...	...	...	0.235	...	...	...	...	...	0.035	0.380	...
12. ....	1.035	...	...	...	...	...	...	0.025	...	...	...	...
13. ....	...	...	0.880	...	0.045	...	...	...	0.225	...	...	...
14. ....	0.020	...	...	...	...	...	...	...	...	1.755	...	...
15. ....	...	...	...	0.495	...	...	0.035	0.750	...	0.050	...	0.575
16. ....	...	...	...	...	1.445	...	...	...	...	...	...	...
17. ....	...	0.445	...	...	...	...	...	...	0.015	...	0.520	...
18. ....	1.475	...	...	0.145	...	...	...	...	...	...	...	...
19. ....	...	...	0.105	...	...	1.540	0.325	...	...	...	...	...
20. ....	...	...	...	...	...	...	...	...	...	1.075	...	...
21. ....	...	0.740	2.220	...	...	...	...	...	0.015	...	...	...
22. ....	1.080	...	...	...	0.115	2.155	...	0.530	...	...	...	...
23. ....	...	...	0.030	...	...	...	...	...	...	0.480	0.265	0.380
24. ....	...	...	...	...	...	...	0.410	0.010	...	...	...	0.540
25. ....	1.010	0.010	...	0.090	...	...	...	...	...	...	...	...
26. ....	...	1.080	...	...	0.075	...	...	...	...	...	...	0.350
27. ....	0.080	...	...	...	...	...	...	...	...	0.170	1.405	...
28. ....	...	0.120	...	...	...	0.010	...	1.470	...	...	0.030	...
29. ....	0.370	...	...	...	0.630	0.010	0.665	...	0.060	...	...	...
30. ....	...	...	...	...	...	...	0.855	...	...	...	...	0.940
31. ....	...	...	...	...	0.010	...	...	0.355	...	...	...	...
Totals . .	6.245	5.075	6.070	3.150	2.480	4.430	3.180	3.880	2.160	4.735	2.605	3.410

Total rainfall during the year, 47.400 inches, being an average of two gauges, located at Mystic Lake and Winchester.

# ENGINEERING DEPARTMENT.

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*Monthly Rainfall in Inches, during 1891, at Various Places in Eastern Massachusetts.*

Place.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lake Cochituate . . . . .	6.67	5.02	5.49	3.82	1.67	3.78	2.99	4.91	2.12	4.14	2.84	3.17	46.43
Framingham . . . . .	6.92	5.12	6.63	3.76	2.17	3.37	3.07	5.22	2.35	3.70	3.04	3.76	49.11
Dan 4, Ashland . . . . .	7.12	5.35	6.32	4.05	1.86	4.17	3.73	4.23	2.41	3.96	3.14	3.61	49.93
Chestnut Hill . . . . .	6.93	5.34	5.63	2.98	2.06	4.04	3.44	4.04	3.05	5.70	2.70	3.73	49.63
Mystic Station, Winchester . . . . .	6.20	5.17	5.96	2.80	2.37	4.33	3.20	3.66	2.01	4.53	2.43	3.20	45.55
Mystic Lake . . . . .	6.29	4.98	6.19	3.60	2.56	4.53	3.16	4.10	2.31	4.94	2.78	3.63	49.96
Mystic Pumping-station . . . . .	5.99	4.85	5.68	2.55	2.31	4.09	3.29	3.72	2.67	5.06	2.50	3.45	46.45
Boston Pipe-yard . . . . .	6.11	5.27	5.35	2.53	2.69	2.86	3.18	3.74	1.53	5.50	2.65	3.66	45.12
Cambridge Observatory . . . . .	6.09	4.56	4.90	2.44	2.10	3.57	2.93	3.21	2.03	4.82	2.23	3.29	42.76
Waltham, Boston Manufacturing Co. . . . .	5.71	4.83	5.96	3.14	1.93	4.02	2.63	5.32	2.53	4.34	2.67	3.90	47.18
Lowell, Locks and Canals Co. . . . .	7.041	4.841	6.004	3.564	2.289	3.659	3.199	2.144	1.787	2.926	1.918	3.204	42.546
Lowell, Merrimac Manufacturing Co. . . . .	6.62	2.631	4.292	2.80	1.96	3.20	2.62	1.385	1.296	2.60	0.93	3.09	33.833
Average of twelve places . . . . .	6.474	4.830	5.692	3.169	2.162	3.802	3.133	3.943	2.298	4.351	2.435	3.474	45.643

*Rainfall Received and Collected 1891.*

MONTH.	SUDBURY.			COCHITUATE.			MYSTIC.		
	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.
	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.
January . .	7.020	5.283	76.69	6.67	6.26	93.81	6.245	6.286	100.67
February .	5.235	5.616	107.28	5.02	6.62	131.93	5.075	5.969	117.61
March . . .	6.475	7.944	122.69	5.49	8.08	146.26	6.070	7.208	118.74
April . . .	3.905	4.188	106.97	3.62	4.31	119.15	3.150	3.434	109.01
May . . . .	2.010	1.089	51.70	1.67	0.88	52.75	2.460	1.402	57.01
June . . .	3.770	0.714	18.92	3.78	0.77	20.36	4.430	1.010	22.80
July . . . .	3.895	0.266	7.83	2.99	0.50	16.65	3.180	0.422	13.37
August . .	4.725	0.290	6.15	4.91	0.72	14.69	3.890	0.429	11.31
September .	2.380	0.350	14.71	2.12	0.76	35.91	2.160	0.417	19.32
October . .	3.880	0.375	9.78	4.14	0.79	18.95	4.735	0.575	12.14
November .	3.090	0.526	17.08	2.84	0.83	29.21	2.805	0.565	21.06
December .	3.685	0.971	26.34	3.17	1.60	50.47	3.410	0.573	25.59
Totals and averages }	49.520	27.512	55.76	46.42	32.07	69.08	47.400	28.000	60.34

*Table showing the Temperature of Air and Water at Various Stations on the Water-Works.*

1891.	TEMPERATURE OF AIR.						TEMPERATURE OF WATER.	
	Chestnut-Hill Reservoir.			Framingham.			Brookline Reservoir.	Mystic Engine-House.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Mean.	Mean.
January . . . .	54.0	9.0	29.3	51.0	0.0	28.3	36.3	34.0
February . . .	62.0	2.0	31.5	62.0	-1.0	31.1	36.0	34.1
March . . . . .	54.0	0.0	33.8	51.0	0.0	32.9	37.1	35.2
April . . . . .	78.0	24.0	49.5	77.0	24.0	49.0	48.8	48.3
May . . . . .	88.5	30.0	57.3	85.0	30.0	57.3	57.0	58.1
June . . . . .	96.0	42.5	65.9	96.0	38.0	65.4	65.1	68.2
July . . . . .	90.5	51.0	68.6	89.0	46.0	67.5	71.5	70.7
August . . . .	90.0	47.5	70.2	94.0	45.0	69.4	73.6	74.5
September . .	90.0	47.0	67.2	88.0	44.0	65.4	69.7	69.3
October . . . .	86.0	23.5	51.0	84.0	26.0	48.6	58.2	59.5
November . . .	66.0	9.5	41.4	66.0	6.0	39.0	44.6	44.7
December . . .	64.0	12.0	39.2	67.0	8.0	37.8	38.2	39.2



## C.

## IMPROVED SEWERAGE.

The construction of the extension of the Improved Sewerage system has been continued the past year, the amount expended being \$192,409.65.

The condition of the appropriation on Feb. 1, 1892, was as follows :

Total appropriations . . . . .	\$5,913,164 93
Total expenditures . . . . .	5,865,246 41
Unexpended balance Feb. 1, 1892 . . . . .	\$47,918 52

The work done during the year was limited by the funds available, and is described briefly as follows :

## CITY PROPER, SECTIONS 5 AND 6, EAST SIDE.

These sections extend in Atlantic avenue and Commercial street, from Central wharf to Hanover street, a distance of 3,120 feet. The sewers were completed in August and are now in service; for a distance of 2,716 feet from Central wharf the sewer is of brick, egg-shaped, 2 feet 4 inches  $\times$  3 feet 6 inches, with concrete foundations and side walls, and is laid on a grade of 1 foot in 1,500 feet. The remaining 404 feet of sewer is of 15-inch Akron pipe, embedded in and covered by concrete, and is laid on a grade of 1 foot in 200 feet. Tide-gates and sump manholes were built at Hanover and Battery streets, and six common sewers were intercepted at these points. At Clarke street a sump manhole was built and three common sewers were intercepted, and the old outlet in the dock at this point was bulkheaded off. At Clinton street 20 feet of 5 feet  $\times$  6 feet wooden sewer in that street were rebuilt, and a 10-inch inlet pipe built into the intercepting sewer.

In addition to the above work, 70 feet of common sewer (2 feet  $\times$  3 feet brick) was rebuilt near Hanover street, and 160 feet of old wooden sewer at Clarke street, which leaked badly, was replaced by a 12-inch Akron pipe, built in the old box sewer and surrounded by concrete.

The work on these sections was done by day labor; it was almost entirely tidework, and was unusually difficult; and the obstructions found in the made land, through which the sewer was built, increased the difficulty and expense of the work. More than 350 cubic yards of stone was taken from

old sea-walls found in the trench ; while timber, in the shape of wharves, foundations, piles, etc., was encountered in large quantities.

All of the sewers which formerly emptied into the docks along the water-front, in the city proper, are now intercepted.

#### DORCHESTER.

On August 19 the sum of \$58,000, which had been appropriated in 1890 for the settlement of land damages at Squantum and Moon Island, was, by vote of the city government, made available for the purposes of Improved Sewerage construction.

Work was at once begun on Section 8, Dorchester, by day labor, with the force previously employed on Sections 5 and 6 of the east side intercepting sewers, and is now in progress. This section extends, in the valley of the Neponset river, along the northerly line of the location of the Old Colony Railroad, through private land, from Marsh street to Granite avenue, a distance of 1,950 feet. The sewer is of brick, 4 feet 6 inches in diameter, and is laid on an inclination of 1 foot in 2,000 feet. The trench varies in depth from 20 feet to 39 feet, and can be worked to advantage in the winter season.

Section 10, Dorchester, extends in Butler, Adams, and Washington streets, at Dorchester Lower Mills, from Huntoon street to the foot of Baker's court, a distance of 1,600 feet. A contract for building this section was awarded in January, 1891, to A. A. Hall, and the work was completed by him in November last, at a cost of about \$41,000. The sewer is laid on a grade of one foot in 2,000 feet; it is of brick, egg-shaped, 3 feet by 4 feet; the excavation was made by tunnelling, with the exception of a short, open cutting on each end; the material was solid rock, conglomerate and slate being found in about equal proportions; the space between the brickwork of the sewer and the surrounding rock was solidly filled with concrete. The average distance from the surface of the ground to the roof of the tunnel was about 25 feet, yet no damage resulted to the buildings fronting on the streets, from the jar or vibration of the ground. At one point a five-story brick building stood within 23 feet of the centre line of the tunnel, with the bottom of its foundation-walls 15 feet above the tunnel roof; the building was not injured. The only damage done during the progress of the work was a slight breakage of glass in the windows of some of the houses in close proximity to the shaft-openings, due directly to the concussion of the air.

Travel on the surface of the street was not seriously interrupted.

No work has been done on Sections 6, 7, 9, and 11, Dorchester, owing to want of appropriation.

#### OUTFALL SEWER.

Section 3, outfall sewer, was being constructed at the time of the last annual report, under contract, by H. P. Nawn. This section extends for 2,100 feet in the embankment between Squantum and Moon Island. The sewer is of brick, 12 feet wide and 11 feet high. It has an unusually heavy concrete foundation, with side walls of rubble masonry — iron rods passing through the foundation and arch, as described in last year's report. During the past year 1,300 feet of sewer has been built, and there remains 350 feet to be built under Mr. Nawn's contract.

The completion during the coming summer of the remaining 1,920 feet of sewer in the embankment is imperative. The wooden flume, which now conveys the sewage from Squantum to Moon Island, has been in use seven years, and is in a decidedly dangerous condition. Many of the supporting piles are eaten by worms, and much of the woodwork is badly decayed. Great care and constant repairs will be necessary to maintain the flume in working order for another year.

An appropriation of \$90,000 will be necessary to complete this sewer which will replace the flume. The work can be done during the coming summer if a beginning is made as soon as the weather permits.

During the past year a total length of intercepting sewer of 5,385 feet has been built.

An appropriation of \$355,000 will be required to complete the Improved Sewerage system as proposed. This includes Sections 6, 7, 8, 9, and 11 of the Dorchester Intercepting, the sewer from Squantum to Moon Island, the seawall at Moon Island, and the pumping-station at the East shaft of the Dorchester-Bay tunnel.

#### SECTION 1, BRIGHTON INTERCEPTING SEWER.

The contractors for building this difficult section of sewer was the National Construction Co., of Boston, who should have been credited with the successful construction of this work in last year's report, but by an error the credit was given to other parties.

## D.

[FROM THE CITY ENGINEER'S REPORT TO THE BOARD OF  
PARK COMMISSIONERS.]

## THE PARKWAY. — BACK BAY FENS.

*Excavation of Waterway.* — At the beginning of the year there remained a small portion of the waterway in Longwood entrance which had not been excavated. This was done early in the season, and this part of the work is now entirely completed. The dredging-plant has been sold to the Water Department.

*Roadways and Walks.* — Audubon road has been finished to Brookline avenue, and was opened to travel on January 3, 1892.

The roadway and walks on and near Agassiz bridge have been resurfaced, the curbstones reset, and the gutters repaved. This was made necessary by the settlement of the filling in that vicinity.

The Fenway between Huntington and Tremont entrances has been graded, except a small part occupied by piles of loam. The ride on this section has been nearly all surfaced, and the walk next the water has been graded, its gutters built, and a portion of it covered with crushed stone. On March 20, 1891, contracts were made with Cape Ann Granite Co. for furnishing 2,838 lineal feet of curbstone at \$1.49 per lineal foot, and with S. & R. J. Lombard for furnishing 110,000 paving-blocks, at \$44.90 per thousand. Both of these contracts have been completed.

The stone-crusher has been run continuously since September 2, and a large amount of stone is now on hand for use on the roads and walks during the coming season. The stone for crushing has been purchased as needed, from different parties, at prices varying from 75 to 90 cents per ton.

*Filling.* — At the Tremont and Longwood entrances all the filling required has been done under a contract with the Boston & Albany R.R. Co., dated September 16, 1890. The work was completed on February 4, 1892, and the total amount of filling deposited was 161,099 cubic yards, at 51 cents per cubic yard.

*Agassiz Bridge.* — The parapet walls of this bridge have been built, thus completing this structure.

*Fen Bridge.* — On November 24, 1890, a contract was made with Mr. William H. Ward, of Lowell, for building this bridge, with the exception of the face walls above the water

level. He began work February 20, 1891, and finished on September 29. The face-walls were built by masons in the employ of the Park Department. The entire work was completed on November 17.

This is a masonry arch bridge of 15 feet span and a width of 96 feet. The foundation is of spruce piles capped with 10 × 10 inch spruce caps, which are covered with 4-inch spruce plank, the surface of the plank being at grade —0.5. The abutments are of granite, 12 feet 6 inches high; and the arch is of brick except at the ends, 20 inches thick, with a rise of 4 feet; the ends of the arches, the wing-walls above grade 7.5, and the parapet are all of rustic masonry composed of Roxbury stone, all except the voussoirs laid dry, with the spaces between the stones filled with loam. The parapet is of quarried stones very roughly dressed, while the stones below the parapet are field bowlders laid without any cutting. The cost of the whole structure was \$27,669.34.

*Stony-brook Bridge.* — On June 23, 1891, a contract was made with Sampson, Clark, & Co., of Boston, for building the superstructure of this bridge. Work was begun on July 1, and it is nearly completed. The bridge spans the waterway leading from the outlet of the new channel of Stony brook and supports the main drive and ride of the Fenway. It consists of five arches of 10-feet span each —three over the waterway and two over foot-paths on either side of the waterway. The bridge is 85 feet wide between the parapets. The arches are supported by piers 2 feet square except at the ends of the main piers, where they are 2 feet × 3 feet 6 inches. Below grade 9.5 the piers are supported by a continuous wall 2 feet thick. At the southerly side of the bridge there is at each end a flight of steps leading from the walks next the driveways from Huntington avenue to the walks passing under the bridge, which latter connect with the walks along the borders of the main waterway; by this means a passage is furnished to people on foot to all parts of the Fens without crossing the drive or ride at grade. In connection with these passageways, recesses for seats are built in the abutments of the bridge. On the northerly end of the bridge there is to be an iron foot-bridge, just above the level of the water, to connect the two walks. The face-work of the masonry is of speckled brick, with trimmings of Milford granite. The barrel vaults underneath the bridge are lined with glazed brick of different colors, laid in patterns. On each staircase there is a drinking-fountain, and the walls are piped for lighting the drive, and also the walks under the bridge. The foundations of the bridge were built

in 1887 by the Sewer Department, as a part of the new channel of Stony brook.

The work was done under the direction of this department, from designs furnished by Messrs. F. L. Olmstead & Co., and Walker & Kimball, architects.

*Culvert and Retaining-wall at Brookline Avenue.*—The culvert under Brookline avenue, connecting Muddy river with the waterway in the Fens, has been extended, and the foundations for a retaining-wall at its end have been built. The culvert is elliptical in section, 9 feet high and 7 feet wide, with side walls of concrete lined with brick and a brick arch 12 inches thick. It is on a pile and timber platform. There is a rectangular manhole at the end, with grooves for stop-plank. The retaining-wall at the end of the culvert is semicircular in plan, and is built of concrete, resting upon a pile foundation to grade 7; above grade 7 the wall is to be of bowlder work of the same character as the face-walls of the Fen bridge. This bowlder work was not included in the contract, and has not yet been built. The contractor for this work was Mr. Wm. H. Ward, of Lowell. His contract was dated June 23, 1891; work was begun on July 1 and finished on January 7, 1892. The cost of the work covered by the contract was \$8,042.

*Grading of Slopes, Loaming, and Planting.*—The slopes between the ride and the water on that part of the Fens between Huntington and Tremont entrances have been graded and covered with loam, except a small portion near Stony-brook bridge. The slopes on the Longwood entrance and on a part of the Tremont entrance have been finished in the same manner.

*Miscellaneous.*—Fifty additional settees have been purchased and placed along the walks. The regrading of the plantations on Commonwealth avenue, between West Chester park and Beacon street, has been completed, and the section between West Chester park and Charlesgate East has been planted.

The following table, giving the principal items of work completed, has been corrected to date:

		Per cent. of whole.
Channel excavated	. . . 1,227,000 sq. ft.	100
Shore completed	. . . 26,700 lin. ft.	100
Marsh completed	. . . 833,000 sq. ft.	100
Driveway completed	. . . 60,000 sq. yds.	68
Walks completed	. . . 24,000 "	46
Ride completed	. . . 8,000 "	60
Curbstone set	. . . 25,946 lin. ft.	75
Gutters paved	. . . 13,300 sq. yds.	67

		Per cent. of whole.
Area covered with loam . . .	1,023,000 sq. ft.	75
Area planted . . .	841,500 "	60
Boundary fence . . .	4,047 lin. ft.	26
Drain laid . . .	6,498 "	
Manholes . . .	6	
Catch-basins . . .	77	
Bridges and culverts . . .	6	

A large amount of other work has been partially completed, but cannot be classified.

The usual force engaged upon the care of plantations, roads, walks, etc., has been employed during the year, and the expense of the same has been charged to the appropriation for maintenance.

#### MUDDY RIVER AND STONY BROOK COVERED CHANNELS.

The former of these remains in bad condition, as was described in the report for 1887. As the town of Brookline contemplates improving the channels of the brooks flowing into Muddy river, so that in time of freshet the discharge of water into the new open channel through the Parkway will come more suddenly than it does at present, in my opinion it is necessary that the covered channel should be repaired and all obstructions removed. The Stony-brook conduit is in good condition, except that the temporary work at the outlet into Charles river has been somewhat damaged by storms. The gate-chamber has been provided with window-frames and sashes, the same having been omitted when it was built.

#### MUDDY RIVER.

The contracts in force at the date of the last annual report have all been completed, except a small portion on Section C. The buildings on the Downer-street section were removed early in the summer, and on June 23 a contract was made with Richard D. Shanahan for grading this section. The work was completed in December.

The payments under the above five contracts were as follows, the names given being those of the contractors :

<i>Section A.</i> — James Killian . . .	\$14,896 24
<i>Section B.</i> — Owen Nawn . . .	6,883 05
<i>Section C.</i> — Edward F. Brigham (contract not finished) . . .	10,503 92
<i>Section D.</i> — H. P. Nawn . . .	87,304 73
<i>Downer-street Section.</i> — Richard D. Shanahan .	4,576 33

All of the above contracts included the excavation of the waterway and the upland and the disposal of the excavated material as filling on ground which required it. The material was not sufficient for doing all the filling required, nor was much of it suitable for foundations for roads and walks.

On Oct. 21, 1891, a contract was made with the Boston & Albany Railroad Company for furnishing and depositing all filling required on that portion of the improvement north and west of the waterway between Brookline avenue and the city boundary. The work is now in progress. A contract was made on November 28, with Moulton & O'Mahoney, for doing all the grading required on that portion of the improvement on the south and east of the waterway, extending as far as Perkins street. This work is progressing favorably. Preliminary plans for the bridge on Brookline avenue having been furnished by Messrs. Olmsted & Co., working plans and specifications were prepared, in consultation with this department, by Mr. A. H. French, engineer for the Brookline Park Commissioners. A contract for building this bridge was made on December 30 with John Sheehan, of Lynn, and work is now in progress under the direction of the Brookline Park Commissioners.

Plans are now being prepared for the Tremont and Bellevue street bridges, and proposals for doing the work will shortly be received.

Arrangements having been made in conjunction with the town of Brookline for the transportation of loam from Basin 6 of the Boston Water-Works, a contract was made with James A. Cahill on July 14 for grading a branch railroad from the main line of the Boston & Albany Railroad to the basin; the work was completed in September, at a cost to the city of Boston of \$1,750.18; on September 28 a contract was made with the Boston & Albany Railroad Company for laying the track on the above branch railroad, and for transporting the loam to the Parkway; nothing has yet been done for the Boston Park Department under this contract, except the laying of the track.

The drain from the House of the Good Shepherd having been cut off by the removal of the sewer in Downer street, it was extended by a siphon under the waterway, and connected with the sewer in Brookline avenue.

#### ARNOLD ARBORETUM.

At the beginning of 1891, work was in progress on the grading of the road around the north side of Bussey hill and



across the meadow to the Parkway near Centre and Orchard streets, under a contract with Wm. T. Davis. This contract was subsequently amended, so as to include the grading of the road leading from the before-mentioned road to the Parkway near South street. Another contract was made on July 23 for grading a temporary road across the Parkway to Centre street. The work called for by these contracts has been finished. The total amount of material moved under them was 70,035 cubic yards, and the payments were \$24,945.51. There remains a small amount of grading to be done where there has been a settlement of the filling across the meadow. On about 1,700 lineal feet of this road — being the portion of the north side of Bussey hill — the catch-basins and drains have been built, the gutters paved, and the roadway ballasted.

On the road leading from the main drive to Walter street, the catch-basins and drains have been built and the gutters paved. The Water Department has laid a 24-inch water-pipe through this road, but the work not having been completed until recently, the road has not been surfaced; it can be done early in the spring.

#### FRANKLIN PARK.

*Drives, Rides, and Walks.*— Glen-lane wall has been completed, but the delay in doing it caused by the press of other work for the masons has prevented the completion of the surfacing. The section between Blue Hill avenue and the entrance road from Columbia street has been entirely finished, while on the section between the last-mentioned road and the crossing of old Glen road the drains and catch-basins have been built and most of the gutters paved, so that it will require but a short time to complete the work.

The triangular space between Blue Hill avenue, the entrance from Columbia street, and the easterly end of the Greeting has been graded, and the plantations prepared for planting. The circle at the easterly end of the Greeting has been graded. The curbstone has been set, the gutters paved, and the roadway ballasted. Loop road has been finished, and the last section of it was opened to travel on May 24. The walks in the vicinity are nearly finished, and 1,500 lineal feet of granite steps have been purchased for the same. The ride through the Wilderness has been surfaced. Circuit drive is sub-graded from the junction with the road to Columbia street, around the easterly side of the Park to the entrance from Morton street, except a short section across the valley near Canterbury street, where a culvert is to be

built, and a section between Canterbury hill and the pond which requires filling. On about 800 lineal feet of the Circuit drive the gutters have been paved and the roadway ballasted.

The walk from Ellicottdale to the top of Scarboro' hill has been built.

*Drainage.* — The main drain at the westerly end of the Greeting has been extended so as to drain the swampy ground near by. Drains have been built on the easterly end of the Greeting, on Glen lane, and on Circuit drive.

*Ellicottdale.* — That portion of this ground where the gardener's cottage formerly stood has been finished.

*Schoolmaster Hill.* — The masonry work of the arbor and of the shelter has been completed, including an additional drinking-fountain. The wookwork of the arbor for supporting vines has been erected, so that this structure is complete, except paving of the walks.

*Ponds.* — Work is now in progress on the excavation of the proposed ponds south of Scarboro' hill, the material being used for filling on Circuit drive, and for building a dam between the ponds and Morton street.

*Miscellaneous.* — A shelter at the carriage-stand at the entrance to the Park opposite Columbia street is in progress of construction. The flock of sheep increased during the year to 168 in number, and in the fall 64 wethers and old ewes were sold for \$350.88. The yield of wool was 792 lbs., which was sold for \$187.74. In May lamp-posts and lanterns with oil lamps were placed along Glen lane by the Lamp Department, and they have since been maintained by that department.

The following table shows the principal items of work completed to date, but it should not be understood as being a complete statement of the work done, as a large amount of labor has been expended on work which cannot be classified :

Driveways completed . . .	76,000 sq. yds., or 5 miles.
Walks completed, . . .	47,700 " or $6\frac{1}{4}$ miles.
Ride completed . . .	10,500 " or $\frac{1}{4}$ of a mile.
Gutters paved . . .	15,100 "
Curbstone set . . .	6,460 lin ft.
6-in. water-pipe laid . . .	3,000 "
4-in. water-pipe laid . . .	1,150 "
Hydrants . . .	7
Drinking-fountains . . .	8
Bridge . . .	1
Boundary wall . . .	4,468 lin. ft.
2-ft. 9-in. brick drain . . .	706 "

2 ft. × 2 ft. × 6 in. brick drain . . . . .	180 lin. ft.
2-ft. brick drain . . . . .	769 "
18-in. pipe drain . . . . .	3,020 "
15-in. pipe drain . . . . .	2,895 "
12-in. pipe drain . . . . .	1,546 "
10-in. pipe drain . . . . .	1,844 "
8-in. pipe drain . . . . .	7,914 "
4-in. pipe drain . . . . .	190 "
4-in. agricultural tile drain . . . . .	2,100 "
3-in. agricultural tile drain . . . . .	3,520 "
2-in. agricultural tile drain . . . . .	26,713 "
1½-in. agricultural tile drain . . . . .	19,700 "
Total drain . . . . .	71,097 "
Manholes . . . . .	41
Catch-basins and inlets . . . . .	143
Open channel for brook . . . . .	2,300 "
Area of ground graded and planted or seeded . . . . .	85 acres.
Gateway . . . . .	1

800 lineal feet of Circuit drive have been ballasted and covered with crushed stone, while 2,200 lineal feet have been sub-graded and drained.

### MARINE PARK.

*Filling.*—The filling done under the contract with Joseph E. White, dated October 5, 1889, was completed on October 16, 1891. There were deposited 268,450 cubic yards; the amount paid was \$163,754.50. The work of filling north of Broadway, under the contract with Perkins & White, dated September 10, 1890, is still in progress, there having been deposited 310,000 cubic yards.

*Loam.*—On October 12, 1891, a contract was made with Perkins & White for furnishing and placing loam on that portion of the Park south of the south line of Broadway extended. This work is now in progress.

*Q-street Bulkhead.*—On February 14, 1891, a contract was made with Perkins & White for building a bulkhead on easterly line of Q street, extending northerly 440 feet from East First street, for retaining the filling on the Park. The work was completed in November, at a cost of \$4,985.

*Castle-island Bridge.*—On July 14, 1891, a contract was made with William L. Miller for building a temporary pile-bridge to connect the mainland with Castle island. Work was begun on August 4, and will be completed early the coming season.

*Miscellaneous.*—Additional toilet accommodations for

men have been provided at the refectory building. One hundred settees have been placed upon the iron pier, and a new boat purchased.

#### WOOD-ISLAND PARK.

Additional land and flats having been taken for an extension of the Park, thereby rendering necessary a revision of the plan. But little work of construction has been done. A topographical survey of the land taken has been made.

The grounds prepared in 1890 have been planted.

#### CHARLESBANK.

*Men's Gymnasium.* — The grounds and apparatus having been put in thorough repair, the gymnasium was opened for the season on March 30. Beginning on May 19, the gymnasium was opened in the evening until 9.30 o'clock. For this reason 13 electric-arc lights were provided within the grounds. This change has been very popular, the attendance in the evening during the warm weather having been large and very orderly. The nights having become so cool that the evening attendance had largely fallen off, the evening opening was discontinued on November 7. The gymnasium was closed for the season on January 2, 1892. The attendance for the season was 169,591, an average of 707 per day. Of this number there attended after 7 o'clock P.M. 46,548, or an average of 312 per evening.

Experience has shown that further accommodations in the shape of bathing and dressing rooms are very much needed in connection with the gymnasium.

*Women's Lavatory Building.* — This building was completed early in the season, it having been constructed under the direction of Messrs. Walker & Kimball, architects. It is of two stories, the lower story being devoted to rooms for the boatmen and workmen and a tool-shed. The upper story is occupied as a woman's lavatory and entrance to the women's gymnasium. Toilet accommodations and boxes for depositing clothing are provided, and turnstiles, with a register attached, control the passage to the gymnasium.

*Women's Gymnasium and Girls' Playground.* — During the spring the gymnastic apparatus furnished by D. A. Sargent, M.D., was put in place, the frames for supporting the same having been erected the previous season. This apparatus consists of the following pieces :

- 2 balance swings and frames.
- 2 seesaws, with side-rails.

- 2 seesaws, plain.
- 2 single swings.
- 2 pole ladders.
- 2 perpendicular ladders.
- 4 perpendicular ladders, combined.
- 5 serpentine ladders.
- 1 horizontal rope-ladder.
- 2 perpendicular climbing-poles.
- 4 long inclined poles.
- 4 short inclined poles.
- 4 hanging-ropes.
- 12 swinging-ropes.
- 1 long inclined rope, with attachments.
- 1 set of high parallel bars.
- 1 set of movable parallel bars.
- 2 sets of horizontal bars, adjustable.
- 2 sets of flying-rings, with pulley attachments.
- 2 single trapezes, with pulley attachments.
- 11 travelling-rings, with attachments.
- 2 giant strides.
- 12 pairs chest weights.
- 1 set of vaulting-bars.
- 1 set of movable standards for high jumping
- 98 pairs wooden dumb-bells.
- 98 pairs wooden Indian clubs.
- 98 short wands.
- 25 long wands.
- 24 iron quoits.
- 12 iron hoops.
- 12 jumping-ropes.

A temporary fence was built around the gymnasium to serve as a screen until the trees and shrubs have become grown. Closets for the dumb-bells, wands, etc., also, sixteen dressing-booths were built within the enclosure. Three sand-courts were constructed in the rear of the building. The Girls' Playground consists of a smooth lawn around which runs a cinder track an eighth of a mile in length. A wooden shelter with seats overlooking the playground has been built under the direction of Messrs. Walker & Kimball.

The gymnasium and playground were opened on June 1 and closed on October 31. They have been in the charge of the Massachusetts Emergency and Hygiene Association, which has provided for their superintendence and the instruction of those using the apparatus. The attendance during the season in both the ground and gymnasium was 144,539, of which number 13,010 were admitted to the play-

ground on Sundays, the gymnasium being closed on that day. The average attendance on week days was 1,095.

*Brick Walk.* — On September 29, a contract was made with Adelard Phaneuf for paving with brick the walk along Charles street. The work was completed on November 17, and there were laid 3,190 square yards of walk, at a cost of \$4,822.10.

*Miscellaneous.* — Fifty additional settees have been purchased, and temporary awnings have been erected over a portion of them.

#### CHARLESTOWN PARKS.

On August 11 a small force was set at work on Charlestown Heights grading the grounds, which work is still in progress.

At the playground, on Alford street, the Street Department is dumping ashes for filling, and considerable material has been received from other parties without expense to the city; the buildings have been removed from the Guild property with one exception, and the vats of the old tannery filled with earth.

#### MISCELLANEOUS.

Various land-surveys and plans have been made during the year, including those of the land taken for the Dorchester Park on Dorchester avenue and Adams street, for the proposed extension of the South Boston Parkway, and for a proposed muster-ground. Estimates have been made of the cost of various improvements under consideration by the department.

## E.

[FROM THE CITY ENGINEER'S REPORT TO THE STREET  
DEPARTMENT.]

MR. H. H. CARTER, *Superintendent of Streets*:

SIR: I herewith submit the following report of the work done under my direction for your department.

Plans and profiles of streets to be paved were made, quantities estimated, and specifications prepared.

The work done is shown in the accompanying tables; the city furnished all material except paving-gravel, and generally the materials were delivered to the contractor from wharves or from city yards. In some cases the paving-blocks were delivered by the city on or in the vicinity of the work. Such of the old materials as the city could use were delivered by the contractor.

It will thus be seen that the prices contained in the tables have no comparative value, since the conditions differed on each street, some being paved, others macadamized or gravelled; also the length of haul for new supplies and for disposing of old material, and the relative quantity of each, was far from uniform.

Under seventeen contracts, 4.35 miles of street were paved at a cost, exclusive of material furnished by the city, of \$169,161.02.

The following is a brief summary of the items:

52,744 sq. yds. block paving on gravel furnished were laid at an average cost of \$1.155 per sq. yd.

9,294 sq. yds. block paving on a cement concrete base, with pitched joints, were laid at an average cost of \$2.727 per sq. yd.

15,189 sq. yds. of asphalt paving were laid; average cost, with cement concrete base, \$3.635 per sq. yd.; when the old base was used, the cost was \$2.025 per sq. yd.

31,509 linear feet of edgestones were set at an average cost of \$0.329 per linear ft.

21,372 sq. yds. sidewalk were relaid at an average cost of \$0.836 per sq. yd.

3,079 sq. yds. of flagging cross-walks were laid at an average cost of \$1.184 per sq. yd.

The specifications of one contract provided that the city

should furnish the gravel and remove the old materials. The quantities of work done under that contract have been included in the totals of work done in the above statements, but they have not been used in determining the average costs. Counts of paving-blocks used in small areas actually laid are found to be variable. The average of the largest areas where exact number of blocks used is obtainable is about 25 large and about 38 small blocks to the square yard. The cost of blocks, including culling and wharfage, is about five cents per small block, and seven and one-half cents per large block, making the cost for blocks per yard \$1.90 in each case. The small blocks came from Quincy, Mass., and were used for suburban streets; they were delivered on the work. The large blocks came mostly from Cape Ann, and were delivered on wharves.

The average cost of block paving on a gravel foundation was  $\$1.15 + \$1.90 = \$3.05$  per sq. yd.

The work was done under somewhat severe specifications, requiring the removal of 13 inches of old material, the grading and rolling the road-bed, and the furnishing of 6 inches of new gravel. The cost of supervision and inspection is not included in the above. Details of the work done are as follows:

*A Street, South Boston*, from Broadway to First street, was paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was of cobble paving. The old cobbles were hauled to the crusher at Broadway bridge, the surplus earth to L-street extension; the new paving-blocks were hauled from the New York & New England R.R. wharf, and the edgestones and flagging from the Albany-street paving yard.

*First Street*, from New York & New England R.R. to F street, was paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was generally of gravel, with concrete patches, and one block from E street to F street was paved with cobbles. The old cobbles were hauled to the crusher at Broadway bridge, the surplus earth to the L-street dump. The new granite blocks were hauled from the New York & New England R.R. wharf and from the Bay State wharf, the edgestones and the flagging from the South End yard; the edgestones were delivered to the contractor on the street.

*Troy street*, from Harrison avenue to Albany street, was paved with granite blocks on a gravel foundation, by James Grant & Co. The old surface was of macadam, and was very hard. The cobble-stones in the gutter were hauled to the Broadway-bridge crusher, the earth and macadam to



East Chester park, between Swett street and New York & New England R.R. ; the new granite blocks, and all other new materials furnished by the city, were delivered from the Albany-street yard.

*Longwood avenue*, from Huntington avenue to Parker street, was paved with granite blocks on a gravel foundation, by James Doherty & Co. The old surface was of macadam ; the surplus earth was hauled to Parker street, near Huntington avenue ; the cobble-stones from the gutters to the Tremont-street crusher ; the Quincy paving-blocks were delivered on the street, and all other materials furnished by the city were hauled from the Albany-street yard.

*Austin street, Charlestown*, from Main street to Rutherford avenue, was paved with granite blocks on a gravel foundation, by John Turner & Co. The old surface was of macadam. The surplus material was the property of the contractor, and the cobble gutter-stones were purchased by him from the city ; the granite paving-blocks and the cross-walks were delivered to the contractor on the street, and the other materials came from the Charlestown paving yard, on Medford street.

A short section of the street in front of a church was paved with asphalt by the Barber Asphalt Paving Company.

*Fulton street*, from Richmond street to Lewis street, was paved with granite blocks on a gravel foundation, by B. F. Nay & Co. The old surface was paved with cobble-stones, which were hauled to the crusher at Broadway bridge ; the surplus earth was disposed of by the contractor ; the granite paving-blocks and all paving materials were delivered from the North End paving yard, on Commercial street.

*Columbus avenue*, from the railroad bridge to West Chester park, was nearly all resurfaced by the Barber Asphalt Paving Company. The concrete base where defective was patched, and if not found at proper grade was brought to grade, the new concrete furnished being paid for by the cubic yard. A portion of the street was patched by the company at its own expense, under a five-year guarantee given in 1887 ; a small portion of the old surface was patched. A plan has been prepared and filed with the contract showing the areas under guarantee, and the time of expiration of the same. The old material was wasted and used for filling on Parker street. The new work is to be kept in order by the company for five years under the contract.

*Bedford street*, from Chauncy to Columbia street, and *Kingslon street*, from Summer to Bedford street, were

paved with granite blocks, with pitched joints on a Rosendale cement base, by H. Gore & Co.

The surface was paved, and a portion of the old blocks were used in the new work; the culls were hauled to Scotia street on the Back Bay; the surplus earth was hauled to Parker street; the new granite blocks were hauled from Wales wharf; and the other new material from the Albany-street yard.

*Dudley street*, from Washington street to Blue Hill avenue, was repaved by James Grant & Co. The old surface was partly of macadam and partly paved with granite block paving. The old blocks of suitable quality were used in repaving, and the culls were delivered to the Bird-street yard; the surplus filling was delivered on Marshfield and Shirley streets; the new Quincy granite blocks and the sidewalk bricks were delivered to the contractor on the street, and the other new material was hauled from the Albany-street yard.

*Terrace street*, from Tremont to New Heath street, was paved by A. A. Libby & Co. The old surface was of macadam, and the old material was used for surfacing several streets within a radius of one mile from Terrace street. The new Quincy blocks, the edgestones, and the sidewalk bricks were delivered on the street. The new flagging was hauled from the Albany-street yard. The joints of the paving opposite the school-house, next Tremont street, were pitched at an extra expense of seventy-three cents per square yard.

*Second street*, from B street to Granite street, and *Third street*, from A street to Second street, South Boston, were paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was cobble-stone paving, the old stones were hauled to the crusher at Broadway bridge, and the surplus excavation was hauled to the L-street extension. The new granite blocks were hauled from the New York & New England wharf, the sidewalk bricks were delivered on the street, and the flagging was hauled from the Albany-street yard.

*Tremont street*, from Scollay square to Boylston street, was paved with granite blocks on a Rosendale cement concrete base, by H. Gore & Co. The work was let in two sections, with Temple place as the point of division. The old granite blocks were delivered by the contractor on sundry streets, within one and a half miles' haul, and the surplus earth was the property of the contractor. The new granite blocks were hauled from Burnham's wharf, the paving-bricks were delivered on the street, and the flagging

in part was delivered from the Albany-street yard, and in part delivered on the street. The joints of the new paving were filled with hot screened pebbles and hot paving-pitch.

*Second street*, from Dorchester to E street, South Boston, was paved with granite blocks on a gravel foundation, by J. Doherty & Co. The old surface was of cobble paving. The old cobbles were delivered on Ninth street, opposite H street; the surplus excavation was delivered on the L-street extension. The new granite blocks were hauled from the Bay State wharf, the paving-bricks were delivered on the street, and the flagging hauled from the Albany-street yard.

*Dorchester street*, from Dorchester avenue to Ninth street, South Boston, was paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was partly paved with granite blocks and partly macadamized. The old granite blocks in good condition were used in the new work, and the culls and surplus earth were delivered by the contractor on sundry streets within half a mile, mostly on Washburn street; the old cobble gutter-stones were hauled to the crusher at Broadway bridge; the new paving-blocks were hauled from the Thompson & Baker coal wharf on Ninth street; the paving-bricks were delivered on the street, and the flagging was hauled from the Albany-street yard. The paving in front of the school-house was laid with pitched joints.

*Beacon street*, from Arlington street to Charles street, was paved from the street-railroad track to the northerly edge-stone with asphalt on a Portland cement concrete base, by the Barber Asphalt Paving Company. The gutters and toothing strip next the railroad track were paved with granite blocks, partly delivered from Burnham's wharf and partly delivered on the street; the surplus excavation was hauled to Scotia street. The remainder of the street between the same points was repaved with the old granite blocks, by J. Doherty & Co. This portion was the narrow strip under the trees, adjoining the Public Garden. The joints in the paving were filled with hot pebbles and pitch.

The accompanying table, showing the length of accepted streets in Boston, the area of roadway in each, and the area of each kind of paving or roadway construction, have been prepared for the use of the Street Department. This table is an entirely new computation from the best obtainable original sources. The measurements have been principally made from careful surveys of the Surveying Department, and when information could not be obtained from original surveys, the streets have been measured. They have also been examined to determine the character of the paving, and as it is impossible to determine

rick sidewalk. n F.	For laying crosswalk. Item G.		Extra work. Item H.	Total final estimate.
Final estimate.	Bld.	Final estimate.	Final estimate	
1,124 sq. yds. \$1,022 84	\$1 15	175 sq. yds. \$201 25	\$27 60	\$4,669 89
1,897 sq. yds. \$1,726 27	1 15	337 sq. yds. \$387 55	491 72	16,186 24
627.5 sq. yds. \$828 30	1 98	72.5 sq. yds. \$143 55	87 40	4,379 44
1,774 sq. yds. \$1,170 84	0 27	206 sq. yds. \$55 62	29 90	8,157 62
700 sq. yds. \$700 00	1 50	76 sq. yds. \$114 00	34 25	2,951 90
621 sq. yds. \$391 23	0 55	14.5 sq. yds. \$7 98	346 15	2,829 78
				4,081 25
462 $\frac{1}{2}$ sq. yds. \$420 88	2 34	134 $\frac{1}{2}$ sq. yds. \$314 78	231 21	6,972 05
4,124 sq. yds. \$3,257 96	1 42	342 sq. yds. \$769 64	185 97	14,432 27
1,720 sq. yds. \$1,290 00	1 30	113 sq. yds. \$146 90	584 48	9,543 98
	1 05	237.5 sq. yds. \$249 88		13,559 18
1,518 sq. yds. \$1,381 38	1 35	122 sq. yds. \$164 70	245 20	6,982 09
987 sq. yds. \$843 30	2 74	276 sq. yds. \$717 24	393 29	12,859 30
1,100 sq. yds. \$990 00	2 74	394 sq. yds. \$1,079 56	591 82	13,802 50
2,128 sq. yds. \$1,659 84	1 00	172 sq. yds. \$172 00	291 35	9,010 42
2,639 sq. yds. \$2,190 87	1 35	207 sq. yds. \$279 45	294 63	9,987 83
1,372 sq. yds.	\$1.173	3,079 sq. yds.		
\$17,873 21	\$1.184	\$4,803 55	\$3,834 97	\$140,305 24 28,855 78 \$169,161 02

travel, at \$1.37	\$317 55	
" " \$0.65	67 82	
\$0.15	20 60	
walk, at \$0.40	418 00	\$1,324 07
concrete, at \$2.25	\$23,553 00	
e, at \$3.50	4,038 71	
	\$27,591 71	
from city	60 00	27,531 71
		\$28,855 78



Table showing Lengths and Areas of Paving on Accepted Streets.

*This is a new table made from official plans and actual surveys, and not compiled from previous reports. Correct to Feb. 1, 1892.*

	LENGTH IN MILES.							AREA IN PAVEMENT IN SQUARE YARDS.								
	Asphalt.	Block.	Brick.	Cobble.	Macadam.	Gravel.	Not Graded.	Totals.	Asphalt.	Block.	Brick.	Cobble.	Macadam.	Gravel.	Not Graded.	Totals.
Year 1891 Report . . . . .	3.2	64.9	. . . . .	6.5	174.6	160.9	. . . . .	409.7	54,070	1,429,620	. . . . .	109,890				
City Proper, Feb. 1, 1892.	*4.07	39.67	0.36	4.41	81.33	0.78	0.07	86.69	65,665	860,833	3,638	52,156	606,675	13,207	1,204	1,603,388
Charlestown "	0.03	7.68	. . . . .	0.29	14.46	0.03	0.06	22.54	421	178,060	. . . . .	2,836	219,471	161	762	401,811
East Boston "	. . . . .	3.50	. . . . .	0.48	2.09	20.30	0.18	26.55	. . . . .	83,286	. . . . .	9,621	39,536	389,142	3,555	525,140
South Boston "	0.33	10.24	. . . . .	0.76	23.33	1.82	5.71	42.18	4,271	218,076	. . . . .	14,969	405,661	38,178	118,371	799,511
Roxbury "	0.23	6.38	. . . . .	0.01	52.24	16.06	0.70	75.62	3,569	139,776	. . . . .	717	982,370	268,319	9,530	1,349,171
West Roxbury "	. . . . .	0.09	. . . . .	. . . . .	24.67	47.29	0.67	72.72	. . . . .	2,067	. . . . .	. . . . .	433,826	739,700	10,492	1,186,085
Dorchester "	. . . . .	1.73	. . . . .	. . . . .	40.01	36.59	1.47	79.80	. . . . .	39,444	. . . . .	. . . . .	718,362	613,177	31,060	1,401,973
Brighton "	. . . . .	. . . . .	. . . . .	. . . . .	16.43	16.61	1.45	34.49	. . . . .	. . . . .	. . . . .	. . . . .	399,365	254,749	26,977	681,091
Total . . . . .	4.66	69.29	0.36	6.94	204.56	139.48	10.30	434.59	73,906	1,521,662	3,638	80,389	3,755,106	2,311,628	201,941	7,948,170

Total Public Streets, 434.59 miles.

NOTE.—In the above table the City is sub-divided on the original boundary-lines between the districts.

\*Of this amount, 0.48 miles, or 8,501 square yards, Asphalt Blocks.

at this season of the year whether a street is macadamized or simply gravelled, the table has been checked by the district foreman and by the Deputy Superintendent of Streets. In giving lengths and areas, care has been taken to include intersections of streets but once, and the detail table shows the streets from which the intersections have been deducted. The general rule has been to include intersections as part of the principal street.

The engineering force has done considerable work of a miscellaneous character, and numerous estimates for new work have also been made.

#### BENNINGTON-STREET CULVERT.

Plans and estimates were made for a wooden culvert across Bennington street, between Saratoga street and Wadsworth street.

#### BERKELEY-STREET BRIDGE, OVER THE B. & A. R.R.

A contract was made with John Cavanagh & Co., dated October 9, 1891, for taking down the parapets and bridge seats of Berkeley-street bridge and rebuilding the same with granite masonry laid solid in cement mortar, of the dimensions required to receive the new bridge. This work is now complete, with the exception of one parapet stone which cannot be placed until the truss used for a temporary support of the telephone wires is removed.

The contract price for the work is \$2,290.

An agreement was made with the Boston Bridge Works, October 7, 1891, for removing the old bridge, for the sum of \$350. The work called for under this agreement has been completed, with the exception of the sidewalk truss carrying the telephone wires, which was moved sufficiently to allow the new bridge to be placed. As soon as the wires are in place on the bridge, this truss will be removed.

The new superstructure is a through plate girder bridge, consisting of six lines of plate girders, dividing the street into two roadways; two sidewalks and a centre walk is also used for two lines of water-pipes. The bridge is seventy-one feet long and seventy-eight feet six inches wide between centres of sidewalk girders. The four roadway girders have curved upper flanges five feet six inches deep at centres, and four feet six inches deep at ends. The two sidewalk girders are four feet six inches deep, with straight upper flanges, and are to have hand-rails on top. The floor-beams for the roadway are built beams, and for the walks are 9-inch steel I beams.

The roadway and sidewalk stringers are of hard-pine, the roadway flooring-plank is of spruce, the under course being four inches thick and the upper course two inches thick. The sidewalk is planked with 2-inch hard-pine.

The contractor for the ironwork was the Boston Bridge Works, and the contract price was \$4,898.

The wooden flooring and the painting of the bridge have been done by the Bridge Division.

#### CHELSEA BRIDGE, NORTH, STEAM-POWER.

Machinery for moving both the north and south draws of Chelsea bridge by steam-power has been erected and is now ready for use. On the pier of the south draw, there is an engine-house 15×20 feet, in which is placed a double 6×12 inch engine and boiler. An endless chain passes around the turntable drum of the draw, and the power is transmitted from the engine by bevel gearing, a horizontal shaft, and sprocket wheel.

At the north draw an addition 26 × 32 feet has been made to the draw-pier on which the engine-house is placed. This draw is to be moved by means of wire ropes attached to the draw and to a 36-inch drum in the engine-house. A reversing-engine with two 6 × 12 inch cylinders will furnish the power.

At each draw a winch-head has been placed for working vessels through the draw by steam-power.

The machinery has been furnished and set up by Miller & Shaw, and the engine-houses and other woodwork was done by the Bridge Division.

#### CHELSEA BRIDGE, NORTH, FENDER-GUARD.

Plans and specifications for building a fender-guard 173 feet long at the north draw of Chelsea bridge have been made.

#### CORNWALL-STREET BRIDGE, OVER STONY-BROOK CHANNEL.

A plan and bill of material for a new bridge on Cornwall street were furnished, and the structure has been built by the Bridge Division.

The bridge has a single span, 32 feet long over all, and a total width of 40 feet, divided into a roadway of 26 feet and two sidewalks of 7 feet each. The span consists of 12 lines of trussed beams, each made of two 6 × 12 inch hard-pine sticks, trussed by a 1½-inch diameter rod.



The roadway planking is of spruce, the under course being 4 inches thick and the upper, or sheathing course, being 2 inches thick. The sidewalk is planked with 3-inch planed hard-pine.

The end supports of the bridge are timber bulkheads, each having nine 10 inch  $\times$  10 inch hard-pine posts, with a 6 inch  $\times$  10 inch hard-pine sill, sunk about 9 feet into the ground, and capped with a 12 inch  $\times$  12 inch hard-pine stick.

#### HILL-STREET RETAINING-WALL.

A contract was made with Donovan & Brock, Boston, dated October 6, 1891, for building a retaining-wall at the easterly end of Hill street, on the line of Sackville street.

The wall is of granite, laid solid in cement mortar, and rests on a concrete foundation. The wall is capped with a granite coping, and has on top a close board fence 5 feet high.

Total amount paid contractor, \$1,485.

#### IRVINGTON-STREET AND YARMOUTH-STREET RETAINING-WALLS.

These walls are located one on each side of the Providence Division of the Old Colony Railroad, at the ends of Irvington and Yarmouth streets, the streets being in line with each other.

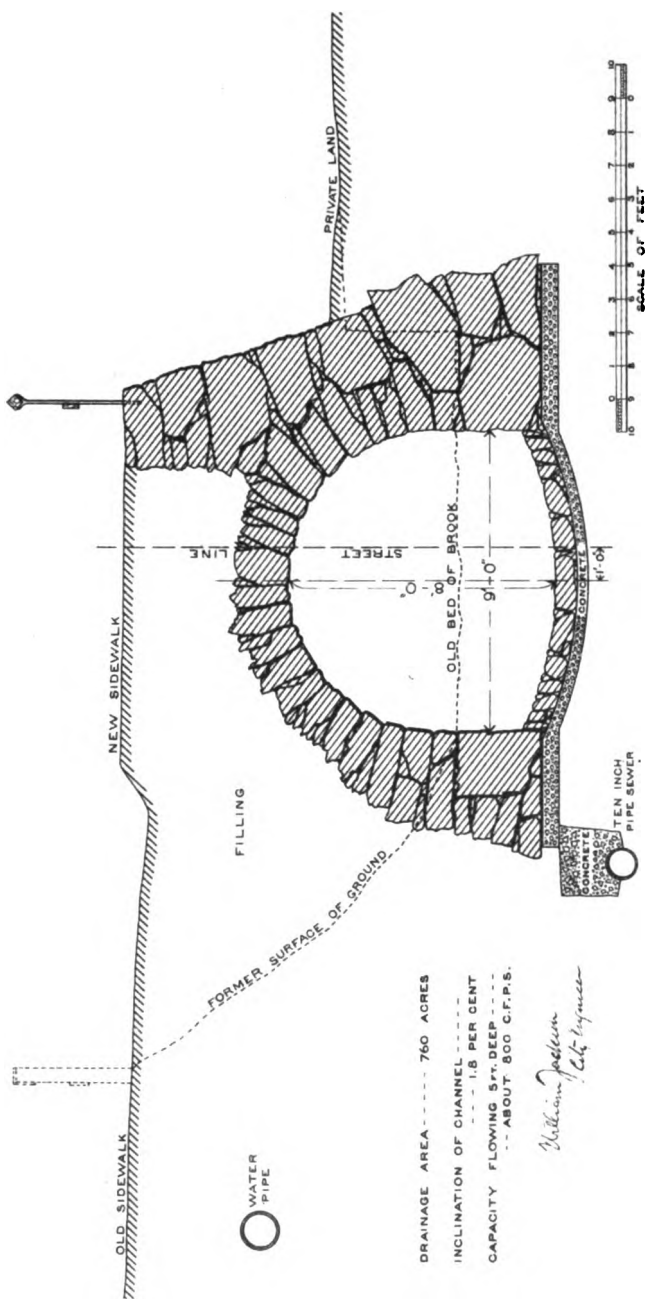
A contract was made with R. D. Shanahan, dated June 15, 1891, for building a retaining-wall at the end of Irvington street, and for adding buttresses to the retaining-wall at the end of Yarmouth street.

The wall is of granite laid solid in cement mortar, and rests upon a pile foundation with concrete cap. Granite buttresses were built at the back of the wall to afford a sufficient foundation for the piers of an iron foot-bridge. At the back of the wall on Yarmouth street, similar buttresses were built of concrete, with granite coping-stones.

The total cost of the work, including the repointing of the wall on Yarmouth street, was \$3,537.

#### IRVINGTON-STREET FOOT-BRIDGE, OVER PROVIDENCE DIVISION, OLD COLONY RAILROAD.

An iron foot-bridge has been built over the tracks of the Providence Division of the Old Colony Railroad, on the line of Irvington and Yarmouth streets. The bridge is a through bridge of the riveted bowstring type, resting upon wrought-iron piers. The tops of the piers are on a level with the floor of the bridge, and are reached by stairways from the



DRAINAGE AREA ----- 760 ACRES  
 INCLINATION OF CHANNEL -----  
 ----- 1.8 PER CENT  
 CAPACITY FLOWING 5 FT. DEEP -----  
 ----- ABOUT 800 C.F.S.

# STONY BROOK IMPROVEMENT CROSS SECTION OF NEW CHANNEL AND RETAINING WALL WASHINGTON STREET : ROSLINDALE

1891



sidewalks of each street. The stairways are of wrought iron with hard-pine treads. The bridge was built by the R. F. Hawkins Iron Works, of Springfield, Mass., under contract dated Sept. 16, 1891, at a total cost of \$1,773.

#### L-STREET ABUTMENT.

The contract for building the south abutment of L-street bridge was let to Perkins & White, of Boston, under date of Oct. 28, 1891, for \$5,925, and calls for the completion of the work on or before June 15, 1892. At this date the piles have been driven and capped for the foundation, and the larger portion of the ballast and rip-rap placed.

#### L-STREET BULKHEAD, SOUTH BOSTON.

Plans and specifications were made in 1890 for extending L-street bulkhead northerly from the bulkhead built in 1889; the length of bulkhead to be built being 727 feet, enclosing 328½ feet of street extension.

The contract for building the bulkhead was awarded to F. G. Whitcomb for \$7,200; the work was begun April 23 and completed July 27, 1891, at a total cost of \$7,210.

#### ROXBURY-CANAL SEA-WALL.

Plans and specifications were made for building a sea-wall on Roxbury canal and adjacent dock at the Paving wharf of the Street Department.

No work has yet been done on the wall.

#### STONY-BROOK IMPROVEMENT.

##### *Roslindale Branches.*

This improvement contemplates a channel sufficiently large to carry the rainfall from a tributary water-shed of about 1,000 acres, and will, when this improvement is completed, prevent the flooding in this vicinity during heavy rains; but until the channel has been farther extended up-stream about 300 feet, there will still be danger of occasional floods.

The work done during the past season embraced both the main branch of Stony brook at Roslindale and also a small brook flowing into it. The larger channel extends from a point on the old brook channel about 160 feet below Poplar street, through private land, and in Poplar and Washington streets, a distance of 665 feet. It is partly open and partly covered. The open portion below Poplar street is 12 feet

wide, with side-walls of rubble masonry nowhere less than 6.8 feet high. It is laid on a grade of 1 foot in 100; the covered channel varies in size from 11 feet 6 inches wide  $\times$  6 feet 6 inches high to 9 feet wide  $\times$  8 feet 6 inches high. Both side-walls and the arch are of rubble masonry; the inclinations are 1 foot in 100 feet and 1 foot in 56 feet; 22 feet of open channel, 9 feet wide, was built at the up-stream end; the bottom is paved throughout with stone or brick, and a concrete foundation extends under both walls and under the paved bottom. The smaller brook channel extends from Birch street through private lands, across Cohasset street, and again through private lands to its junction with the larger channel on the north-west side of Washington street; a total distance of 507 feet. This channel is a stone culvert 4 feet 6 inches high and 5 feet wide; it is laid on an inclination of 1 foot in 125 feet; the side-walls are of rubble with granite covering-stones; the paving is of stone; a concrete foundation extends under the side-walls and under the paved bottom.

Bids for the construction of the work were received July 20, and the contract was awarded to H. P. Nawn, the lowest bidder.

In connection with the brook channels, and during their construction, 340 feet of pipe sewer was built, with the necessary branches, manholes, etc. This sewer was necessary in order to afford drainage to houses on the westerly side of Washington street, which were cut off from the common sewer in that street by the low grade of the new channel; this work was done to much better advantage during the construction of the brook channel than would have been possible after the completion of the work. The sewer is of 10-inch Akron pipe, surrounded by concrete; it is located for a distance of 185 feet immediately outside of the walls of the brook channel, and for the remaining 155 feet, until it enters the common sewer on Washington street, is laid under the new channel, immediately beneath the concrete foundation.

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#### WIDTHS OF DRAW-OPENINGS.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in Appendix A. The openings have all been remeasured for this report.

WILLIAM JACKSON,  
*City Engineer.*

## CITY ENGINEERS.

1850-1892.

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E. S. CHESBROUGH, M. Am. Soc. C. E.,  
Nov. 18, 1850, to Oct., 1855.<sup>1</sup>

JAMES SLADE,  
Oct. 1, 1855, to April 1, 1863.<sup>2</sup>

N. HENRY CRAFTS,  
April 1, 1863, to Nov. 25, 1872.

JOSEPH P. DAVIS, M. Am. Soc. C. E.,  
Nov. 25, 1872, to March 20, 1880.<sup>3</sup>

HENRY M. WIGHTMAN, M. Am. Soc. C. E.,  
April 5, 1880, to April 3, 1885.<sup>4</sup>

WILLIAM JACKSON, M. Am. Soc. C. E.,  
April 21, 1885, to present time.

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<sup>1</sup> Died August 18, 1886.

<sup>2</sup> Died August 25, 1882.

<sup>3</sup> Resigned March 20, 1880.

<sup>4</sup> Died April 3, 1885.

## APPENDIX A.

*Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1892.*

NAME OF BRIDGES.	LOCATION.	NUMBER OF OPENINGS.	WIDTH.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown	1	35	5
"	Over Miller's River	1	35	9
Broadway	Over Fort-Point Channel	1	43	3
Cambridge st.	Ward 25 to Cambridge	1	36	3
Canal	Boston to East Cambridge	1	35	10
Charles-river	Boston to Charlestown	1	36	0
Chelsea (South Channel)	Charlestown to Chelsea	1	38	10
" (North " )	" " "	1	44	10
Chelsea-st. (East Boston side)	East Boston to Chelsea	2	33	1
" (Chelsea side)	" " "		34	3
Commercial-point	Ward 24	1	24	0
Congress-st. (Boston side)	Over Fort-Point Channel	2	43	3
" (So. Boston side)	" " "		43	11
Dover-st.	" " "	1	36	0
Eastern R.R.	Boston to Charlestown	1	35	10
"	Over Miller's River	1	35	10
Essex-st.	Ward 25 to Cambridge	1	36	10
Federal st.	Over Fort-Point Channel	1	41	10

Fitchburg R.R.	.	.	.	.	.	.	1	36	0
" " (for teaming freight)	.	.	.	.	.	.	1	35	11
Grand Junction R.R.	.	.	.	.	.	.	1	35	7
" " "	.	.	.	.	.	.	1	34	8
Granite	.	.	.	.	.	.	1	36	0
Harvard (Boston side)	.	.	.	.	.	.	2	36	8
" (Cambridge side)	.	.	.	.	.	.	.	36	8
Lowell R.R. (freight)	.	.	.	.	.	.	1	35	8
" " (passenger)	.	.	.	.	.	.	1	35	10
Malden	.	.	.	.	.	.	1	43	4
Meridian-st. (East Boston side)	.	.	.	.	.	.	2	59	2
" (Chelsea side)	.	.	.	.	.	.	.	59	0
Mt. Washington-ave. (Boston side)	.	.	.	.	.	.	2	42	1
" " (So. Boston side)	.	.	.	.	.	.	.	42	4
Neponset	.	.	.	.	.	.	1	36	0
New York & New England R.R. (Boston side)	.	.	.	.	.	.	2	40	4
" " " (So. Boston side)	.	.	.	.	.	.	.	40	2
" " "	.	.	.	.	.	.	1	28	4
North Beacon-st.	.	.	.	.	.	.	1	30	2
North Harvard-st.	.	.	.	.	.	.	1	36	0
Old Colony R.R.	.	.	.	.	.	.	1	36	0
" " "	.	.	.	.	.	.	1	36	0
Prison-point	.	.	.	.	.	.	1	36	0
Warren	.	.	.	.	.	.	1	36	0
West Boston (Boston side)	.	.	.	.	.	.	1	36	3
" (Cambridge side)	.	.	.	.	.	.	2	35	8
Western-ave.	.	.	.	.	.	.	1	36	0
" " "	.	.	.	.	.	.	1	36	0
Ward 25 to Cambridge	.	.	.	.	.	.	1	30	0
Ward 25 to Watertown	.	.	.	.	.	.	.	30	0
Boston to Charlestown	.	.	.	.	.	.	.	36	0
" " "	.	.	.	.	.	.	.	36	11
Ward 25 to Cambridge	.	.	.	.	.	.	1	35	7
East Boston to Chelsea	.	.	.	.	.	.	1	34	8
Ward 24 to Milton	.	.	.	.	.	.	1	36	0
Boston to Cambridge	.	.	.	.	.	.	2	36	8
" " "	.	.	.	.	.	.	.	36	8
Boston to East Cambridge	.	.	.	.	.	.	1	35	8
" " "	.	.	.	.	.	.	1	35	10
Charlestown to Everett	.	.	.	.	.	.	1	43	4
East Boston to Chelsea	.	.	.	.	.	.	2	59	2
" " "	.	.	.	.	.	.	.	59	0
Over Fort-Point Channel	.	.	.	.	.	.	2	42	1
" " "	.	.	.	.	.	.	.	42	4
Ward 24 to Quincy	.	.	.	.	.	.	1	36	0
Over Fort-Point Channel	.	.	.	.	.	.	2	40	4
" " "	.	.	.	.	.	.	.	40	2
Over South Bay	.	.	.	.	.	.	1	28	4
Ward 25 to Watertown	.	.	.	.	.	.	1	30	2
Ward 25 to Cambridge	.	.	.	.	.	.	1	36	0
Over Fort-Point Channel	.	.	.	.	.	.	1	36	0
Ward 24 to Quincy	.	.	.	.	.	.	1	36	0
Charlestown to Cambridge	.	.	.	.	.	.	1	36	0
Boston to Charlestown	.	.	.	.	.	.	1	36	3
Boston to Cambridge	.	.	.	.	.	.	2	35	8
" " "	.	.	.	.	.	.	.	36	0
Ward 25 to Cambridge	.	.	.	.	.	.	1	36	0
Ward 25 to Watertown	.	.	.	.	.	.	1	30	0



## APPENDIX B.

*City of Boston, Revised Ordinances, 1892.*

### CHAPTER 12.

#### ENGINEERING DEPARTMENT.

SECTION 1. The engineering department shall be under the charge of the city engineer, who shall be consulted on all matters relating to public improvements of every kind where the advice of a civil engineer would be of service; shall, unless otherwise specially provided, take charge of the construction of all public works of the city which properly come under the direction of a civil engineer; shall, except as to sewers, perform all engineering services, and make all examinations and prepare all statements, plans, specifications, and contracts which any department may need in the discharge of its duties; shall, upon being notified by the superintendent of streets, supervise all repairs on the bridges of the city used as highways which affect the safety of the structures, and shall, when required by the mayor or by any officer or board in charge of a department, measure the work done by contract for the city, and certify to the result of such measurement.

SECT. 2. Said engineer shall in his annual report include a report of the safety and completeness of all ponds, basins, and reservoirs under the charge of the water-supply department, and of all bridges within the city limits used as highways.

## APPENDIX C.

## ENGINEERING DEPARTMENT, PROPERTY SCHEDULE, MAIN OFFICE.

1 horse.	Reference Library, 830 vols.
2 carriages.	7,945 Plans Engineering Works,
1 sleigh.	loose.
2 harnesses.	14 vols. Plans Engineering
3 robes.	Works, bound.
Instruments for drawing.	Photographs of Engineering
Instruments for surveying, as	Works.
follows :	Apparatus for blue-printing.
2 Temple transits.	1 microscope.
5 Buff & Berger transits.	1 mercurial barometer.
5 Gurley transits.	1 aneroid barometer.
1 Stackpole transit.	1 holosteric barometer.
3 Temple levels.	1 set hydrometers.
4 Buff & Berger levels.	1 hygrometer.
5 Gurley levels.	1 pr. field-glasses.
11 Boston rods.	2 typewriters.
4 New York rods.	2 dynamometers.
3 Troy rods.	1 pentagraph.
Cases for plans and books.	1 calculating-machine.

## IMPROVED SEWERAGE CONSTRUCTION.

SCHEDULE OF PROPERTY IN CHARGE OF ENGINEERING DEPARTMENT,  
FEBRUARY, 1892.

2 adzes.	5 desks.
2 augers.	10 drills.
14 axes.	1 diaphragm (Edson pump).
11 bars.	2 drawing instruments (sets).
3 blocks.	3 drawing-tables.
1 blue-print frame.	1 engine, Erie.
2 bookcases.	10 files.
1 Bromley's Atlas, vol. 5.	29 frames, manhole.
5 brooms.	1 grindstone.
9 buildings.	30 gasolene lamps.
1 buggy.	1 harness.
3 brass scales.	17 hammers.
4 calking-irons.	48 handles.
8 chains.	3 hatchets.
14 chairs.	3 hoes.
1 chuck hydrant.	350 ft. hose, hand.
29 covers, manhole.	48 ft. hose, suction.
1 compass beam.	50 ft. hose, steam.
2 cases drawers.	1 horse.
1 derrick, tripod.	1,762 ft. iron pipe, 1½-in.

17 lanterns.  
1 level, hand.  
4 levels, engineers.  
5 levelling-rods.  
12 mauls.  
3 measuring-rods.  
16 mounting-boards.  
24 moulds, cement.  
3 oil suits.  
6 oil cans.  
15 pails.  
1 plummet lamp.  
38 picks.  
1 planimeter.  
9 plumb-bobs.  
2 presses, letter.  
1 pump, hand.  
1 pump, steam.  
paper, drawing.  
4 poles, levelling.  
21 pipe, suction.  
7 rammers.

29 rubber boots.  
2 rubber coats.  
3 rubber hats.  
6 ropes, chain.  
7 rods, sighting.  
2 sand-heaters.  
1 sand screen.  
5 saws.  
4 scrapers.  
49 shovels.  
6 tapes, steel.  
7 tapes, cloth.  
7 stoves.  
130 steps, manhole.  
1 sleigh.  
3 tables.  
3 tool-boxes.  
4 transits.  
1 testing-machine, cement.  
6 wheelbarrows.  
12 wrenches.

## APPENDIX D.

Elevations referred to Boston City Base. (The city base is 0.64 ft. below mean low tide.)

Feet.

- 0.00 City base.
- 15.66 Highest tide, April, 1851.
- 15.33 Coping of dry dock, Charlestown Navy Yard.
- 12.94 Greatest elevation of high tide per U. S. Tide Table, Nov. 5, 1892  $(12.30 + 0.64) = 12.94$ .
- 10.44 Mean high water.
- 8.64 Least elevation of high tide per U. S. Tide Table, 1892  $(8.0 + 0.64) = 8.64$ .
- 2.84 Greatest elevation of low tide per U. S. Tide Table, Sept. 1, 1892  $(2.2 + 0.64) = 2.84$ .
- 0.64 Mean low Tide.
- 1.96 Lowest elevation of low tide per U. S. Tide Table, April 28, 1892  $(-2.6 + 0.64) = -1.96$ .
- 5.00 Piles cut off for building.
- 9.91 Water-Works base (approx. tide marsh level).
- 9.82 South Boston base.
- <sup>1</sup> —4.98 Cambridge City base.
- 0.38 South Boston Flats base.

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<sup>1</sup> Cambridge city base is 4.98 ft. below Boston city base.

## APPENDIX E.

## ENGINEERING DEPARTMENT ANNUAL REPORTS, 1867-1891.

No. of reports.	For the year.	Year published and No. City Document.	No. of reports.	For the year.	Year published and No. City Document.
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Fourth .....	1870	1871—15	Seventeenth .....	1883	1884—55
Fifth and Sixth .....	1871-72	1873—23	Eighteenth .....	1884	1885—54
Seventh .....	1873	1874—20	Nineteenth .....	1885	1886—41
Eighth .....	1874	1875—19	Twentieth .....	1886	1887—38
Ninth .....	1875	1876—24	Twenty-first .....	1887	1888—39
Tenth.....	1876	1877—15	Special report ...	1888	1888—117
Eleventh .....	1877	1878—20	Twenty-second .....	1888	1889—38
Twelfth .....	1878	1879—22	Twenty-third .....	1889	1890—39
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Executive Department  
Report, Document 1,  
Part I. 1891.

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“ “ “ “ “ .....	1881	25	16
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<sup>1</sup> The dates given are for the year in which the document was published.

<sup>2</sup> Department Report.

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“ “ “ “ “ .....	1885	54	8
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“ “ “ “ “ .....	1887	38	7
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“ “ “ “ “ .....	1888	117	6
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“ “ “ “ “ .....	1890	39	7
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“ “ “ “ “ “ “ .....	1886	41	20
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“ “ “ “ “ “ “ .....	1875	19	21
“ “ “ “ “ “ “ .....	1876	24	14
“ “ “ “ “ “ “ .....	1877	15	8
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“ “ “ “ “ “ “ .....	1882	52	10
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“ “ “ “ “ “ “ “ ..	1877	15	8
“ “ “ “ “ “ “ “ ..	1878	20	9
“ “ “ “ “ “ “ “ ..	1879	22	8
“ “ “ “ “ “ “ “ ..	1880	33	7
“ “ “ “ “ “ “ “ ..	1881	25	8
“ “ “ “ “ “ “ “ ..	1882	52	10
“ “ “ “ “ “ “ “ ..	1883	53	8
“ “ “ “ “ “ “ “ ..	1884	55	8
“ “ “ “ “ “ “ “ ..	1885	54	9
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“ “ “ “ “ “ “ “ ..	1891	D.R.	10
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“ “ “ “ “ “ “ “ “ “ ..	1883	53	9
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“ “ “ “ “ “ “ “ “ “ ..	1885	54	9
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“ “ “ “ “ “ “ “ “ “ ..	1890	39	8
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“ “ “ “ “ “ .....	1880	33	18
“ “ “ “ “ “ .....	1881	25	17
“ “ “ “ “ “ .....	1882	52	19
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" " " " " " " "	1885	54	23
" " " " " " " "	1886	41	20
" " " " " " " "	1887	38	15
" " " " " " " "	1888	39	15
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